No. 180. Vol. XXXVIII. Part 2. APRIL, 1953.

# GEOGRAPHY

FORMERLY THE GEOGRAPHICAL TEACHER.

THE QUARTERLY JOURNAL OF THE

## GEOGRAPHICAL ASSOCIATION

Central Office :
c/o The Park Branch Library,
Duke Street, Sheffield, 2.
(Telephone : 25946.)

LONDON :
PUBLISHED FOR THE GEOGRAPHICAL ASSOCIATION BY THE LONDON GEOGRAPHICAL INSTITUTE
MESSRS. G. PHILIP AND SON, LTD., 32, FLEET STREET, E.C.4, AND PRINTED BY
PERCY BROTHERS, LTD., THE HOTSPUR PRESS, MANCHESTER ; AND AT LONDON.
PUBLISHED FOUR TIMES A YEAR.
PRICE TO NON-MEMBERS, 5s. NET. FREE TO MEMBERS OF THE ASSOCIATION.

# CONTENTS

Page

AIR MASS CLIMATOLOGY. A. Austin Miller .. .. .. .. 55

AITS AND BREAKS OF SLOPE ON DARTMOOR STREAMS. R. S. Waters .. 67

A NOTE ON THE 25 FOOT "CONTOURS" SHOWN ON THE ORDNANCE SURVEY 1 : 25,000 MAP. K. M. Clayton .. .. .. .. 77

CARINTHIA. Alice F. A. Mutton .. .. .. .. .. .. 83

THE HYDRO-ELECTRIC POWER SCHEME IN THE GLOCKNER-KAPRUN AREA OF AUSTRIA. R. Cole .. .. .. .. .. .. .. 93

CHILDREN'S REACTIONS TO GEOGRAPHICAL PICTURES. Molly Long .. 100

BLACKBOARD OUTLINE MAPS. H. C. Prudden .. .. .. .. 107

OBITUARY .. .. .. .. .. .. .. .. .. 109

CORRESPONDENCE .. .. .. .. .. .. .. .. 109

GEOGRAPHICAL ASSOCIATION .. .. .. .. .. .. 112

REVIEWS OF BOOKS .. .. .. .. .. .. .. .. 114

NOTE :—The authors alone are responsible for the opinions expressed in their articles.

# GEOGRAPHICAL ASSOCIATION, 1953

*President :* Dr. O. J. R. HOWARTH, O.B.E.

*Chairman of Council :* Professor H. J. FLEURE.

*Hon. Secretary :* Dr. ALICE GARNETT.

*Hon. Editor :* Professor D. L. LINTON.

*Editorial Panel :* Professor D. L. LINTON, Dr. E. W. H. BRIAULT, Mr. N. PYE, Dr. M. J. WISE, Miss M. OUGHTON.

SECRETARIES OF SECTIONS AND STANDING COMMITTEES :

*Primary Schools Section Committee :* Mr. A. F. SPRANGE, 12, Rose Avenue, South Woodford, London, E.18.

*Public and Preparatory Schools Section Committee :* Mr. H. H. F. SIRR, Monkton Combe School, Bath.

*Secondary Schools Section Committee :* Mr. R. COLE, 31, Barholm Road, Sheffield, 10.

*Training Colleges Section Committee :* Miss M. GOSS, Stockwell College, Bromley, Kent.

*Standing Committee for Visual Aids in the Teaching of Geography :* Mr. E. F. MILLS, 29, Egmont Road, Easebourne, near Midhurst, Sussex.

*Standing Committee for Urban Spheres of Influence :* Mr. A. E. SMAILES, University College, Gower Street, London, W.1.

Annual subscription (due on September 1st): 12s. 6d. Life subscription : £10. Cheques and postal orders should be made payable to the **Geographical Association.**

Information on privileges of membership, use of library, branch, student and school membership and arrangements for compounding for life membership is obtainable from the Assistant Secretary, Geographical Association, c/o The Park Branch Library, Duke Street, Sheffield, 2.

Information for contributors of articles to *Geography* is published on the inside back cover of this issue.

**All correspondents requiring a reply should enclose a stamped addressed envelope.**

# AIR MASS CLIMATOLOGY

A. Austin Miller*

WE generally think of the "air mass" notion as dating from the work of Bjerknes during the First World War, but in fact it marks a return to an idea that was prevalent a hundred years ago, the well-established idea of an association of weather types with the direction of the wind. I have quoted elsewhere[1] from a magazine of the 1860's a sentence that suggests that the frontal origin of storms was already suspected ; it refers to "the movements of the polar and equatorial air currents, and . . . the elemental wars to which the confliction of these give rise." Thirty years earlier still, Luke Howard[2] had described the types of rain associated with warm S.W. winds and with "a cooling of a portion only of the air—from the intrusion or the overflow of a warm vaporous current from a lower latitude than our own." He further remarks that "Both of these modes of production may be in action together for a time. A Southerly current, charged with vapour from a warmer region, may be passing Northward, at the same time that a Northerly current may be returning towards the South, in the immediate neighbourhood of the former ; and these two may raise each other, the colder running in laterally under the warmer current and causing it to flow over laterally in its turn, while each pursues in the main its original course. In this case the country, for a considerable space extending from about the line of their junction far into the Southerly current may be the seat of extensive and continuous rain." Meteorological science for the next 80 years turned away from this naïve but essentially sound concept and the simple truth became obscured in the symbolism of mathematical physics. It would be idle to apportion the blame for following this false trail which has led us into a thicket of cyclones, anticyclones and other isobar patterns which, by themselves, do not represent phenomena of either weather or climate ; let us rather rejoice that Bjerknes brought us back to realities and taught us that the wind brings the sort of weather that it has acquired in its recent journey over land and sea, and that the main use of isobar patterns is to reveal (though occasionally to conceal) the distribution of types of air masses.

## THE GEOGRAPHY OF THE WINDS

Since it is the essence of air mass climatology that the wind brings the weather, the chart of the world winds gives the first clue. On this chart there is no mistaking the vital part played by the distribution of continent and ocean. In the northern hemisphere the winter cold of the great land masses of Eurasia and North America gives rise to two dominating high pressure regions, in comparison with which the sub-tropical high pressure belts produced by the "planetary" effect pale almost into insignificance. Even in the southern hemisphere, where the influence of the narrower continents is less dominating, the high pressure "belt" is not a belt at all but a string of three independent oceanic highs round which the winds circulate independently.

---

* Professor Austin Miller is the Head of the Department of Geography at the University of Reading. This article formed the main part of a lecture delivered to the Annual Conference of the Association on December 31st, 1952.

[1] *Weather*, May, 1950.

[2] *The Climate of London*, 1833, vol. I, p. 117.

### Wind Belts versus Circulation Cells

In our teaching we are accustomed to explaining the origin of the high pressure regions in three stages :—

(1) The hypothetical circulation on a non-existent stationary earth as a result of unequal distribution of warmth at equator and poles.
(2) The general circulation on a theoretical uniform rotating earth ; this leads us to the wind belts.
(3) The influence of land masses which breaks up these "belts" into independent "cells" of circulation.

It is a fault presumably of our teaching that pupils still think that the wind belts really exist. It must be made absolutely clear that the earth's surface is *not* uniform, and that the wind belts on a uniform earth (stage 2) are as unreal as the theoretical winds on a stationary earth usually described in stage 1, before Ferrel's law is thrown into the explanation. May I illustrate this error from the Western Margin Warm Temperate or "Mediterranean" climates. Gloriously simplified, these are said to have easterly trade winds in summer and variable westerlies in winter. No such error could have gained common currency if the chart of actual world winds had been consulted.

Below are given some figures of relative frequencies of winds in midsummer for some Mediterranean climates.

Where are the trade winds ? Reference to the chart of world winds would show that these regions lie at the easterly periphery of the

PERCENTAGE WIND DIRECTION, MIDSUMMER MONTH

| July | N. | N.E. | E. | S.E. | S. | S.W. | W. | N.W. | Calm |
|---|---|---|---|---|---|---|---|---|---|
| San Francisco .. | 0 | 1 | 0 | 1 | 5 | 56 | 36 | 0 | 0 |
| San Diego .. | 6 | 1 | 0 | 1 | 5 | 26 | 27 | 28 | 4 |
| Lisbon .. .. | 43 | 3 | 1 | 1 | 2 | 11 | 7 | 31 | 1 |
| Barcelona.. .. | 2 | 12 | 9 | 3 | 19 | 19 | 14 | 6 | 16 |
| Florence .. .. | 8 | 10 | 7 | 6 | 8 | 28 | 25 | 8 | 0 |
| Malta .. .. | 11 | 20 | 4 | 7 | 2 | 4 | 5 | 35 | 12 |
| Athens .. .. | 17 | 26 | 4 | 2 | 10 | 12 | 5 | 5 | 19 |
| | | "Trades" | | | | | | | |
| January | | | | | | | | | |
| | | | "Trades" | | | | | | |
| Santiago .. .. | 3 | 9 | 1 | 11 | 10 | 58 | 4 | 4 | 0 |
| Valparaiso .. | 5 | 6 | 4 | 7 | 11 | 52 | 11 | 4 | 0 |
| Perth .. .. | 2 | 7 | 18 | 16 | 28 | 22 | 5 | 2 | 0 |
| Adelaide .. .. | 11 | 15 | 9 | 14 | 13 | 19 | 7 | 5 | 7 |

anti-cyclonic cells of circulation and that their winds have an important easterly component only at places like Adelaide and Athens, which are not on western margins and where the winds are "Etesian."

The wind belts are part of thermo-dynamic theory, the distribution of land and sea is a geographical factor that should be more strongly emphasised and more fully appreciated in the study by geographers of geographical climates. The circulatory cells must be made the goal of our teaching of winds; the planetary wind belts are only worthy of mention as a step ladder towards their understanding, to be thrown away when understanding has been achieved. But the real significance of the circulatory system lies in its revelation of the origin and dispersal of air masses.

## SOURCES AND DESTINATIONS OF AIR MASSES

The great semi-permanent high-pressure areas are, and must be, the source regions of the air masses, for only here can air acquire by long residence the uniformity of qualities that characterises an air mass in the current sense. In such regions of high pressure the air must be slowly descending; it is therefore a primary quality of air masses at their source that they are dry. Over the oceans they may acquire some moisture but only in the lower turbulent layers, the main body of the air is low in moisture content.

Essentially source regions are regions of calms, but from the base of the slowly descending masses, the air flows spirally outwards, the characters that it has acquired in the region of its source undergoing a gradual modification as it is influenced by the surface over which it travels. The more slowly it travels (i.e. the weaker the wind) the more nearly it adjusts itself to its new environment, but strong winds carry alien qualities far from their source, bringing a breath of foreign climates.

The final destination of the winds is, and must be, one of the great low pressure areas into which air is drawn from all sides. Here air streams of different qualities meet in conflict and are evacuated from the surface.

## MODIFICATION OF TRAVELLING AIR MASSES

The next step is to study the weather brought by the winds as they travel outwards. In broad outline these developing changes are very simple, and involve no new principles that have not become familiar in introductory studies of meteorology. The most difficult problem is to understand what happens at the zone of meeting, and this, too, has been made familiar in the "polar front" theory of depressions which is now in every book on physical geography that includes meteorology.

It is only necessary, at the school stage, to recognise that air masses travelling over regions warmer than their source region are warmed from the bottom upwards and gradually develop instability (with the weather that this implies), while air masses travelling over regions colder than their source region develop a progressive tendency to stability and temperature inversions (with the weather that this implies). At a later stage it will be necessary to introduce the concept of stability and instability aloft, but the essential qualities of climate can be understood without this refinement.

It seems to me a very strong recommendation of this approach that it helps to relate climate to weather. Climate is sometimes defined as average weather—a very unsatisfactory definition so long as the approach to the two studies (weather and climate) is, as at present, so fundamentally different. But much will have been gained if it can be shown that the climate of a place is the statistical frequency with which the weather associated with each air mass (or front) affects the area. For weather is a reality that can be observed and is appreciated by the observer; climate is an abstraction, a confusion of figures of each element divorced from and unrelated to the others, though everybody observes that they occur together. So let us examine the qualities of each air mass at its source, and then trace the development of weather in each as it moves outwards and away.

### POLAR CONTINENTAL (Pc) AIR

Imagine a dense cushion of air, born and bred in the winter stillness of the frozen land of the Canadian North, whose icy chill seeps slowly upwards until, pressed down by the thickening load, the lower layers spread outwards towards the coast, earthbound by the weight of cold. Such air is too dry and too stable for cloud to form; the only condensation is ice-crystal fog. Such is the nature of extreme Pc air in the region of its source.

### CONVERSION TO POLAR MARITIME (Pm) AIR

As it crosses the coast the cold waters of the Labrador current seem mild by comparison with the frost-bound land, and the lower layers are warmed and wetted from below. Then, passing over the comforting waters of the Gulf Stream Drift, it gains more warmth which spreads quickly upwards and the air is transformed into Polar maritime (Pm). The dull heavy-footed temperature inversion melts away, the lower layers become light, and as the top is still heavy it readily develops an effervescent quality, a tendency to turn upside down that meteorologists call instability. Cumulo-nimbus cloud is readily generated and short sharp showers chase each other across the waves. The turbulent mixing within this lively, somersaulting air spreads the dust and water vapour to great heights; the sky is sparkling bright and visibility is excellent between the showers. Such is the weather Pm brings when it thrusts in behind a cold front; the forecasters call it "showers and bright intervals."

There is no need to consider what happens to Pc air when it moves to *colder* regions, because it does not. It is generated in the coldest places on earth and if, by any chance, it is generated elsewhere and moves to some place even colder, its qualities of coldness, heaviness and stability are carried to an even more exaggerated degree. But Pm, except when it is returning from a long detour into warmer realms, is always relatively cold, and therefore unstable.

### TROPICAL CONTINENTAL (Tc) AIR

Over the land the "Horse Latitudes" high pressure cells are interrupted in summer; continents in these latitudes are not, as a rule, true source regions of air masses at this season. But air passing over these arid lands, or, especially in winter, issuing out from them, acquires characters that entitle it to special consideration as Tc air. Droughty, scorching hot, and therefore turbulent and dusty though it is by day, a refreshing coolness comes with the night, stability returns and the dust settles to reveal a starry sky. But when desert air is on the march, invading neighbouring lands in a steady stream, such as the Harmattan, the heat, the drought, the dust and the discomfort travel with it. Though it tends towards greater stability in its own body as it leaves the desert, its heat energy encourages convection, and when it meets a moist air mass, as along the Mediterranean front, it may bring down copious rain. In winter it may act as a "cold" air mass as it moves towards the equator, but the instability that it acquires is rather of a convective kind, chiefly due to acquiring moisture in its lower layers, which it does very rapidly on passing over the sea.

### TROPICAL MARITIME (Tm) AIR

As Pm was always "cold" so Tc is generally a "warm" air mass, but "Tropical" air which is generated over the oceans in the "Horse Latitudes" high pressure cells comprises two distinct types, for it can move either way—towards colder or towards even hotter places. The former is known as TmW (W = *warm*) because warmer than its new environment and cooled by it: the latter as TmK (K = *kalt*, i.e. cold), because colder than its environment and being warmed by it. Since the divergent streams start at the same temperature we have the paradox that TmK air is actually warmer than TmW.

### TROPICAL MARITIME (COLD) AIR (TmK)

Let us consider first that which moves equatorwards, essentially the trade winds; starting as descending air in the great anticyclonic cells over the tropics where the sea temperature is about 70° F., it makes its way in a steady stream along great sweeping curves towards the doldrums where the sea temperature is over 80° F. The high pressure calm regions from which they start their journey are the driest and most cloudless regions on earth. The air starts stable, warm and, except in the lowest layers, dry. Not until it approaches the equator does it develop instability, when fair weather cumulus clouds become more numerous and eventually grow formidable enough for showers. Converging from the two hemispheres come these two air masses, more and more heavily charged with moisture, their stability more and more precarious. The collision occurs at the "equatorial front" where one or both must take to flight—upwards, with consequences that are well known.

### THE INTER-TROPICAL FRONT

There is some argument as to whether the "equatorial front" is a "front" in the sense that one air mass rides over the other, or whether it is just a "zone of convergence" with relief found by vertical ascent. In some places it is one and in some the other. Broadly speaking it seems to be a convergence zone over the oceans where the two trade winds have almost identical TmK character, but a front over or near land, where one of them, generally the northern hemisphere contribution, has Tc character. But here is another example of the discrepancy between wind-belt theory and geographical fact: the equatorial front is not often at the Equator. Its position varies with the seasons and diverges into quite high latitudes over land masses at the solstices, taking its weather and its contributory winds (now monsoons) with it. For this reason it is better referred to as the "inter-tropical front" rather than the "equatorial front."

### Diurnal Rhythm

At this point it is desirable to introduce the effect of diurnal temperature changes, which, in the relatively short time available, tend to impose a "cold" air mass character by day and a "warm" air mass character by night. This is most easily achieved in calm air such as characterises the doldrums when it is a zone of convergence. The heat of the day breaks down the stability (even inversion) that the cool of the night had brought and so touches off the rain, probably in the afternoon, thus imparting a marked diurnal rhythm of weather events. A similar tendency is responsible for the afternoon maximum of rain in continental climates.

### Tropical Maritime (Warm) Air (TmW)

Now let us return to the Horse Latitudes and follow the other stream of Tm air as it blows polewards as the westerly winds, e.g. from the sunny Azores to the foggy shores of England. Always warmer than the surface over which it goes, a gradual chilling of the bottom layers brings the air eventually near or below the dew point. Fog or low cloud begin to form, trapped beneath a developing inversion. Mild, moist, muggy, dull weather is the result.

But what happens when it comes on land? That depends on the land, on the season and on the time of day. Night and the winter chill it further, build up the inversion and thicken the cloud or fog. Day and the warmth of the summer sun, on the other hand, break down the inversion, set up convection, suck up the fog and disperse the cloud.

The form of the land is very important. Always, as it were, on the verge of tears, Tm air has only to be forced to climb the hills to yield orographic rain, but its inherent stability has to be broken down before it will yield copiously. In this it differs from trade winds (TmK) which ask but little lift from the hills to yield a generous flood. The reason is twofold. In the first place the initial stability of TmK is less, but the second mechanism is even more important. The higher temperature of TmK air implies a greater moisture content (absolute humidity) and once condensation is started the release of latent heat delays the cooling. The lapse rate steepens and soon a state of instability is reached (conditional instability); the hills trigger the action which, once started, feeds itself on the heat energy released.

## THE CAUSES OF RAINFALL

It will be appreciated that some air masses are rain-makers, others are not.

Rain, an important element in climate, is associated with :—

(1) Unstable (i.e. cold) air masses in which convection easily arises. It may also occur in potentially stable masses (e.g. Tm) as a result of heating by the midday sun. Daytime showers and thunderstorms result.

(2) Moist (i.e. maritime) air masses lifted orographically. On the windward side this gives hill fog, drizzle or steady rain according to the height of the barrier. Föhn and rain-shadow effects occur on the lee side. No appreciable diurnal rhythm exists.

(3) Zones of convergence, i.e. fronts, especially the Polar Front and the Inter-Tropical Front. The sequence of rain types along the Polar Front and the association of each with characteristic cloud forms and patterns of weather—warm front, cold front, occlusions, etc.—are well known. Each can be regarded as an entity, a weather unit which is only very slightly sensitive to the diurnal rhythm. The nature of equatorial rain is also well known ; by contrast with conditions at the Polar Front it is strongly affected by the diurnal rhythm.

Each type of rainfall has a characteristic mode of occurrence and a characteristic seasonal and diurnal frequency, in fact an individuality which is part of the weather and ought to be considered as part of the climate.

Drought is associated with :—

(1) Air mass source regions (anticyclones).
(2) Stable air masses, especially on
(3) leesides and continental interiors.

The distribution of rainfall for January and July is explained on this basis in Fig. 1. Similar maps could be constructed for any month of the year.

## THE CLIMATE OF BRITAIN AS THE AVERAGE OF ITS WEATHER

An example of the way in which a knowledge of the properties of air masses can be profitably used in regional climatology is given by R. Miller.[3] Here we will use the British Isles because, though infinitely more complex, their climate and weather are familiar to readers.

The weather at any particular time and place is the weather associated with the air mass in temporary occupation, or is the result of conflict between them for possession of the territory. Four main air masses are involved, whose properties are as follows :—

Pc Mainly late winter, especially February and March. In summer more like Tc if coming from south of east. Easterly wind, often fresh. Cold, often below freezing point, hard black frost. Dry, chaps the hands and dries the hair. Apt to cause respiratory diseases. Raises dust storms after dry spells. Sky hard blue or with layer of stratus cloud. Much fog with light airs. Meeting moist air may cause snow.

---

[3] "The Climate of Nigeria," *Geography*, vol. xxxvii, pt. 4, 1952.

Pm Northerly or westerly, even south-west if "returning." Fresh, gusty. Sometimes gale force behind depressions. Cold, but not freezing. Raw and chilly in winter, cool and bracing in summer. Clear, bright and transparent, showery, snow occasionally, hail in spring. Thundery showers in summer. Much blue sky but large cumulus or cumulonimbus cloud especially over land in summer. Gives fog and frost if stagnating in an anticyclone in winter or spring.

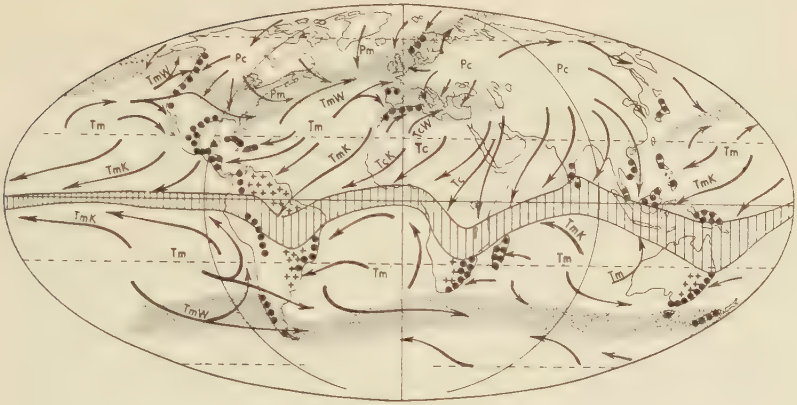
Tc Usually southerly or south easterly. Very hot and dry in midsummer. Characteristic pearly haze, sometimes quite dusty. In winter it takes on Pc character if coming from east of south.

Tm Southerly or westerly, not often strong unless associated with a depression (warm sector). Mild and muggy, enervating. Much stratus cloud and hill fog. Sea fog in summer. Drizzle, orographic rain. High moisture content aids development of thunderstorms in hot summer weather.

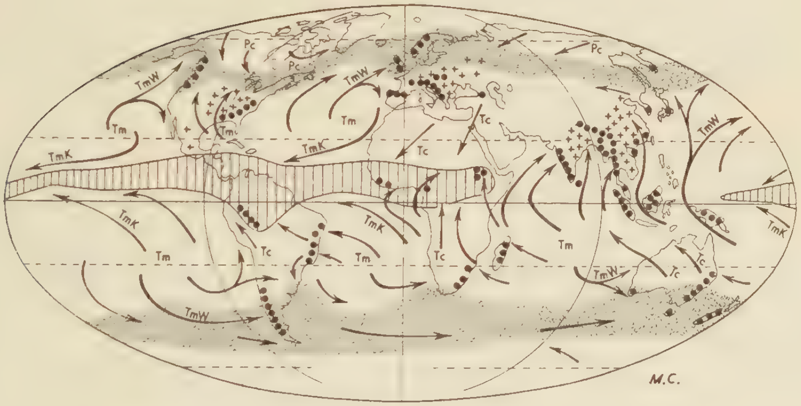
The more usual routes by which these air masses reach Britain are shown in Fig. 2.

Two of them come from the ocean to the west and together constitute our prevailing wind. But they are of very different character and do not flow amicably side by side. Often they come ashore locked in combat, Tm driving a wedge into Pm which encircles the salient and eventually cuts it off (occlusion). Pc air, also, is sometimes involved in the conflict, and in meteorology, as in international politics, Britain lies open to penetration by continental and Atlantic influences. The islands are the battle-ground in a three-cornered fight between the rude east wind of stark Pc air straight from Russia, mild stuffy hot air from the Atlantic high pressure cell and a refreshing draught of gusty Pm air exported from (probably) Canada across the high latitudes of the N. Atlantic ocean. Following the analogy of a fluctuating battle front, contingents from these three bases occupy our territory in turn and in due course are evicted. Continental air gains a footing on our eastern counties, as it did early in December, 1952, there is a hard frost and the skating championships are hurriedly arranged in the Cambridgeshire fens. But before they can be held warm Atlantic air pushes the continental invader back across the narrow seas, only to be rolled up in turn by the charge of the Polar maritime on its left flank, and the echoes of the battle of the Cold Front die away to the East and are occluded, perhaps, over Berlin, by which time the mild Atlantic influence has been squeezed off the earth (occluded).

During its usually brief occupation of territory each victorious air mass seeks to establish therein its own peculiar and consistent regime of weather, which the "liberating" air mass replaces with



JANUARY



JULY

+ Instability rain within air masses.
● Strong orographic element.
▨ Cyclonic rain at Polar & Arctic Fronts.
▥ Convergence rain at Inter Tropical Front.

Fig. 1.—World distribution of rainfall, January and July.

its own variety. This is what they mean when they say that Britain has no climate—only weather. Actually we have three kinds of climate which we enjoy, or endure, in rapid succession, for a few days or perhaps weeks at a time, in the certain and disturbing knowledge that before long we shall be liberated again with all the storms and suffering that the process entails.

If this politico-military analogy sounds a little facetious, it contains, nevertheless, a fundamental truth. Britain's position as an outpost of Europe, set betwixt land and ocean, exposes the "Emerald Isle" and the Atlantic fringe to a higher proportion of pure Tm days than is experienced by the "continental angle," which suffers Pc

TABLE I.—SUMMER.

| Climatic Type | Summer (Equinoctial in Equatorial Climates) | | | | |
|---|---|---|---|---|---|
| | Air Masses & Fronts | Relative Frequency | Temp. and Humidity | Precipitation | Weather |
| Equatorial .. .. | I.T.F. | D | Hh | SS | cmt |
| Tropical .. .. | I.T.F. | D | Hh | SS | cmt |
| | TmK(M) | C | Hh | Ss | s/o |
| Hot Desert .. .. | Tc | D | Hd | DD | sd |
| W.M.W.T. (Med.) | Tc | D | Hd | DD | s |
| | Tm | C | Wh | D═ | o |
| E.M.W.T. .. .. | TmK(M) | D | Hh | Os | st |
| | Tc | R | Hd | D | sd |
| Cool Temperate Maritime .. | TcW | I | Hd | D | st |
| | Tm(M) | C | Wh | , ═ O | o/s |
| | Pm | C | Wd | S | s |
| | P.F. | C | | • • | v |
| Cool Temperate Continental .. | PcK | C | Wd | S | st |
| | TcW | C | Hd | D | sd |
| | P.F. | I | | • • | v |
| Cold Desert .. | Tc | D | Hd | DD | s |
| Cold Maritime .. | Tm | R | Wh | ═ , | o |
| | Pm | C | Ch | SO | s |
| | Pc | C | Wd | D | s |
| | P.F. | C | | • • | v |
| Cold Continental | Pc | C | Wd | S | st |
| | TcW | C | Hd | D | s |
| | P.F. | I | | • | v |

Air Masses and Fronts

| | |
|---|---|
| T | Tropical origin. |
| P | Polar origin. |
| c | Continental origin. |
| m | Maritime origin. |
| K | Relatively cold (unstable). |
| W | Relatively warm (stable). |
| I.T.F. | Inter-tropical Front, violent periodic rains. |
| P.F. | Polar Front of variable weather (including Arctic Front, Mediterranean Front, etc.). |

Frequency

| | |
|---|---|
| D | Dominant. |
| C | Common. |
| I | Infrequent. |
| R | Rare. |

Temperature and Humidity.

| | |
|---|---|
| H | Hot (> 64°). |
| W | Warm (43°–64°). |
| C | Cold (32°–43°). |
| F | Freezing ( <32°). |
| h | Humid. |
| d | Dry. |

| | |
|---|---|
| W.M.W.T. | Western Margin Warm Temperate. |
| E.M.W.T. | Eastern Margin Warm Temperate. |

TABLE I—WINTER

| Climatic Type | Winter (Solstitial in Equatorial Climates) | | | | |
|---|---|---|---|---|---|
| | Air Masses & Fronts | Relative Frequency | Temp. and Humidity | Precipitation | Weather |
| Equatorial . . . . | TmK | D | Hh | Ss | s/o |
| Tropical . . . . | Tc<br>Pc(M)(C) | D<br>R | Hd<br>Wd | DD<br>D | sd<br>sd |
| Hot Desert . . . . | Tc | D | Hd | DD | sd |
| W.M.W.T. (Med.) | TmW<br>Pc(C)<br>TcW(W)<br>P.F. | D<br>R<br>R<br>C | Wh<br>C/Fd<br>Hd/h | , ═ O<br>D<br>D<br>• • | of<br>o<br>o/sd<br>v |
| E.M.W.T. . . . . | TmW<br>Pc(M)(C)<br>P.F. | D<br>I<br>I | Wh<br>Cd | O ,<br>D<br>• | o<br>s<br>v |
| Cool Temperate Maritime . . | Pc(M)(C)<br>Tm<br>Pm<br>P.F. | C<br>C<br>C<br>C | C/Fd<br>Wh<br>Ch | D<br>, , O<br>S*<br>• •* | s/o<br>omf<br>s<br>vt |
| Cool Temperate Continental . . | Pc(M)<br>Pm | D<br>R | C/Fd<br>Ch | D═<br>* | cs<br>bf |
| Cold Desert . . . . | Pc | D | Fd | DD | sd |
| Cold Maritime . . | Pc<br>Pm<br>P.F. | C<br>C<br>C | C/Fd<br>Ch | D<br>*S<br>• * * | s/o<br>r<br>v |
| Cold Continental | Pc<br>Pm | D<br>R | Fd<br>Ch | D ═<br>* | s<br>bf |

| Precipitation | |
|---|---|
| S | Instability showers (diurnal periodicity). |
| s | Conditional instability. |
| O | Orographic. |
| • | Frontal. |
| , | Drizzle. |
| ═ | Fog. |
| * | Snow. |
| D | Drought. |

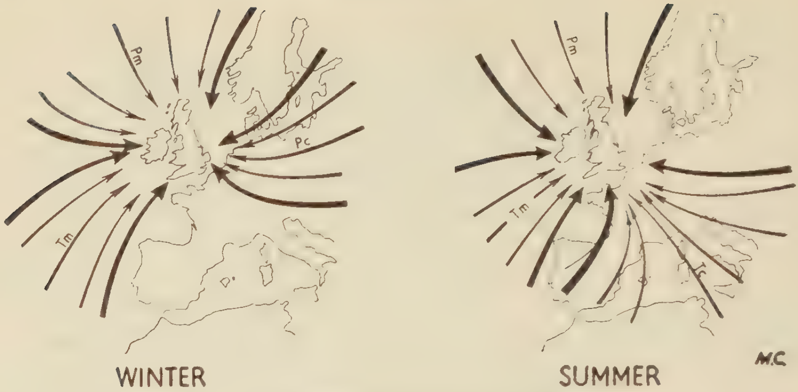
Double symbols mean a great amount.

| Weather | |
|---|---|
| s | Sunny. |
| o | Overcast or dull. |
| m | Muggy. |
| r | Raw. |
| d | Dusty winds. |
| c | Calm. |
| t | Thunderstorms. |
| b | Blizzards. |
| f | Hot dry (Föhn) winds. |
| v | Variable cyclonic weather. |
| s/o, etc. | Chancy, may be one or the other according to circumstances. |

(M) The relative importance of air masses thus marked is greatly increased in monsoon climates.

(C) Cold waves, Bora, Mistral, etc.

(W) Warm waves, Sirocco, Leveche, etc.



WINTER SUMMER

Fig. 2.—Air masses affecting the British Isles.

invasions with greater frequency and severity. Furthermore, each air mass undergoes some modification in its traverse of the relatively small distance across Britain or across the North Sea. Pc air reaching the east coast of Scotland by the long sea passage is appreciably warmer, wetter and cloudier than that which reaches the shores of Kent or East Anglia by the short sea crossing. By the greater or lesser proportion of these two qualities of purity and frequency of occurrence of each air mass and its weather type are explained the climatic contrasts of maritime and continental varieties.

Dr. J. E. Belasco[4] has recently worked out the average duration of occupation of each air mass at three British stations (Kew, Scilly and Stornoway) over a period of 12 years. Table II[5] gives a very much simplified summary for Kew (a relatively continental type) and Scilly (a maritime type).

It is on some such basis of relative frequency in each place that a comprehensive air mass climatology will eventually be expounded. No such frequency figures are available for world climates at present, but in the accompanying table (Table I) I have hazarded an estimation, in general terms, of dominance, rarity, etc., as a rough guide to and explanation of each of the main climatic types. The weather associated with each air mass is indicated by symbols. No claim to precision should be read into it, it is only a tentative suggestion of method.

Fortunately not all areas are as variable in climate as Britain, some regions are dominated by one air mass throughout the season or even the year, and the problem is not nearly so difficult as the complicated British example that I have chosen for illustration might lead one to fear.

Finally I do not suggest that air mass study is a substitute for knowing one's climates. These must still be learnt ; but the approach recommended here provides an easily understood and rational explana-

---

[4] *Characteristics of Air Masses over the British Isles,* A.M.Met. Office, Geophys. Mem. 87, M. O. 530b, H.M.S.O., 1952.

[5] The figures are approximate percentages of frequency ; they do not add up to 100 because days of indeterminate air mass dominance are omitted.

TABLE II

| | J | F | M | A | M | J | Jy | A | S | O | N | D |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| KEW : | | | | | | | | | | | | |
| Tm | 9 | 10 | 8 | 4 | 4 | 8 | 8 | 6 | 6 | 6 | 10 | 8 |
| Tc | 3 | 4 | 5 | 5 | 6 | 6 | 6 | 12 | 6 | 9 | 7 | 2 |
| Pm | 41 | 40 | 30 | 40 | 45 | 44 | 48 | 44 | 39 | 35 | 44 | 33 |
| Pc | 18 | 16 | 12 | 10 | 0 | 0 | 0 | 0 | 0 | 0 | 8 | 10 |
| Frontal | 12 | 8 | 10 | 13 | 11 | 11 | 12 | 13 | 13 | 9 | 12 | 11 |
| SCILLY : | | | | | | | | | | | | |
| Tm | 13 | 16 | 10 | 7 | 6 | 10 | 13 | 10 | 7 | 9 | 17 | 14 |
| Tc | 2 | 2 | 4 | 3 | 2 | 4 | 3 | 7 | 3 | 5 | 6 | 1 |
| Pm | 49 | 34 | 33 | 41 | 45 | 43 | 49 | 50 | 40 | 41 | 43 | 41 |
| Pc | 12 | 17 | 9 | 6 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 7 |
| Frontal | 9 | 12 | 11 | 11 | 15 | 13 | 13 | 13 | 12 | 10 | 12 | 11 |

tion. Furthermore it has the merit, by which I set great store, that it retains the unity of the weather types, and shows that, if treated in this way, climate can be truly described as the average of weather conditions ; these are familiar realities to the inhabitants ; abstract climate is not.

# AITS AND BREAKS OF SLOPE ON DARTMOOR STREAMS

RONALD S. WATERS*

AN *ait* (or *eyot*) is defined by the dictionary as a small isle, especially in a river. To many the word will evoke a picture of the numerous aits of the Thames above London—slim islands some hundreds of yards long, with the main river channel on one side and a narrow backwater on the other. A geomorphologist if casually asked how these islands had been formed would probably suggest that they were " accidents " resulting from the chance formation of a distributary channel by a stream wandering on its flood plain, or by the building up of a midstream shoal till vegetation could take hold of it and turn it into an island strip of dry land. Such an explanation would be, at best, incomplete. Aits are not restricted to the Thames or even to the graded rivers of lowland England. They may be seen on streams of all sizes and in all stages of development draining areas of widely differing geological constitution. In spite of their widespread distribution they have received little attention from students of geomorphology, and the question of their genesis and subsequent evolution appears not to have been discussed.

---

* Mr. Waters is a lecturer in geography in the University of Sheffield. The field work on which his article is based was part of a larger investigation on Dartmoor which was financially assisted by the Research Fund of the University of Sheffield. He wishes to make grateful acknowledgment of this assistance and of aid in meeting the cost of the half-tone blocks. His thanks are also due to Mr. R. W. Toll of Bere Alston for the loan of an Indian Clinometer. All photographs are by the author.

Aits are especially numerous on the rivers of Dartmoor. They have been observed on the Tavy, Walkham, Meavy, Plym, Yealm, Erme and Avon: the late J. F. N. Green noted them on the Dart[1]; and from the 1 : 25,000 map it is clear that they are equally characteristic of the other moorland streams. They are not confined to the granite outcrop nor are they restricted to any particular section of the river. What preliminary observations in the valleys of western Dartmoor did reveal, however, is an apparent relationship between the distribution of aits and breaks of slope in the longitudinal valley profiles The valleys comprise a series of alternating steeper and flatter reaches and many aits were seen to occur at or near the head of the steeper segments. This observation confirms those of Green who recorded their presence in association with knickpoint zones in the polycyclic valley of the Dart[2]. But those aits which lie on flatter reaches also appear to mark the position of minor breaks in the valley profiles: they are frequently accompanied by rapids in the stream itself. In order to obtain further evidence of this apparently intimate association between breaks of slope and aits the profile of a typical moorland stream has been examined in detail.

A clinometer survey was carried out in the Plym valley above Cadover Bridge (20/555646). This valley segment was chosen because it exhibits many irregularities: its long profile is composite, the product of successive rejuvenations, and it also shows minor breaks due in part to structure and in part to the fact that many of its gravel spreads have been worked over by stream tinners[3]. Moreover it exhibits thirteen well-defined aits in the short distance of six miles, aits as variable in size and constitution as any observed on the other streams of western and southern Dartmoor.

For the survey an Indian clinometer was used on a plane table with tripod legs whose spread was so controlled that the height of the instrument remained constant at 3·9 feet above the surface. Sights were taken on a ranging rod. also marked at 3·9 feet, which was set up on the inner edge of the floodplain, or its equivalent on the ungraded reaches, at each perceptible change of gradient. These positions were identified and plotted directly on the six-inch maps on which the horizontal equivalents were subsequently measured. By this means a longitudinal profile was obtained which exhibits in detail along a median line the form of the valley floor (Fig. 1).

The profile comprises a series of concave segments, a succession of relatively well-graded reaches separated by distinct breaks of slope. Each segment is suggestive of a portion of the "normal" curve of water erosion and has, on the confirmatory evidence provided by

---

[1] J. F. N. Green, "The History of the River Dart, Devon," *Proc. Geol. Assoc.*, vol. 60, 1949, pp. 105–124.

[2] J. F. N. Green, *op. cit.*, p. 121.

[3] Most of the valley gravels on Dartmoor, as in other parts of south western England, originally contained a high proportion of cassiterite, the oxide of tin. From early historic, and possibly even prehistoric, times until exhausted these alluvia were systematically turned over by stream tinners seeking the valuable ore which, being heavy, was concentrated near the base of the gravel spreads.

valley-side benches, been accorded cyclical significance. The profile also exhibits minor irregularities of which some appear to be due to human interference but others are clearly the result of structures in the granite. Vertical joints and nearly horizontal "floors," which may be true horizontal joints or pseudo-bedding surfaces, cause the granite to break off in rectangular slabs and form steps in the valley floor. Along this six miles stretch of alternating steeper and flatter reaches the thirteen aits are not distributed arbitrarily: they occur on the steeper segments and, with a few exceptions, each individual ait is associated with a minor break of slope. Table I gives details of valley-floor gradients measured in the neighbourhood of each ait.

TABLE I.—ANGLE OF SLOPE OF THE VALLEY FLOOR IN THE NEIGHBOURHOOD OF EACH AIT.

| Ait No. | Angle of Downvalley Slope | | | Class of Ait |
|---|---|---|---|---|
| | of Valley Floor below Ait | of Ait | of Valley Floor above Ait | |
| 2* | 2°10′ | 1°00′–2°00′ | 1°00′ | II |
| 3 | 2°00′ | 1°00′ | 1°00′ | I |
| 4 | 1°20′ | 1°20′ | 1°15′ | II |
| 5 | 1°50′ | 1°50′ | 1°55′ | III |
| 6 | 1°20′ | 1°30′ | 1°30′ | III |
| 7 | 1°05′ | 0°30′ | 0°30′ | I |
| 8, 9, 10 | 0°40′ | 1°10′ | 1°00′ | II |
| 11 | 2°20′ | 2°50′ | 1°30′ | II |
| 12 | 2°50′ | 2°50′ | 1°20′ | II |
| 13 | 2°10′ | 3°30′ | 2°20′ | II |

* Ait No. 1 is clearly artificial and is therefore disregarded.

The aits fall into three classes according to their location in relation to their respective breaks of slope. Nos. 3 and 7 occur immediately above the break, Nos. 2, 4, 8, 9, 10, 11, 12 and 13 on the steeper reach below the break and Nos. 5 and 6 at the foot of the steeper reach. It is conceivable that these classes represent stages in the cycle of development of this particular kind of ait. From the situation of aits in class I it is apparent that the ait is an erosion feature which, under conditions existing in this valley, is initiated at those points on the stream where active headward erosion is in progress. The prerequisite for its development is the same as that described by Green[4] for the production of complex knicks on rejuvenated rivers, namely, the presence on the valley floor of a permeable layer of gravel resting on a relatively impervious base.

All the Dartmoor valleys are characterised by extensive spreads of drift. It is only in its steeper reaches that the Plym flows in a rock channel, and exposures of the subjacent granite are restricted to equally short stretches in other moorland valleys. For the greater part of their courses the streams flow over superficial deposits of varying thickness, most of which invaded and choked their valleys during the colder phases of the Pleistocene and were subsequently re-sorted and rounded by intensive sluicing by snow meltwater during

---

[4] J. F. N. Green and K. C. Boswell, "A Detailed Profile of the River Test," *Proc. Geol. Assoc.*, vol. 57, 1946, pp. 102–116.

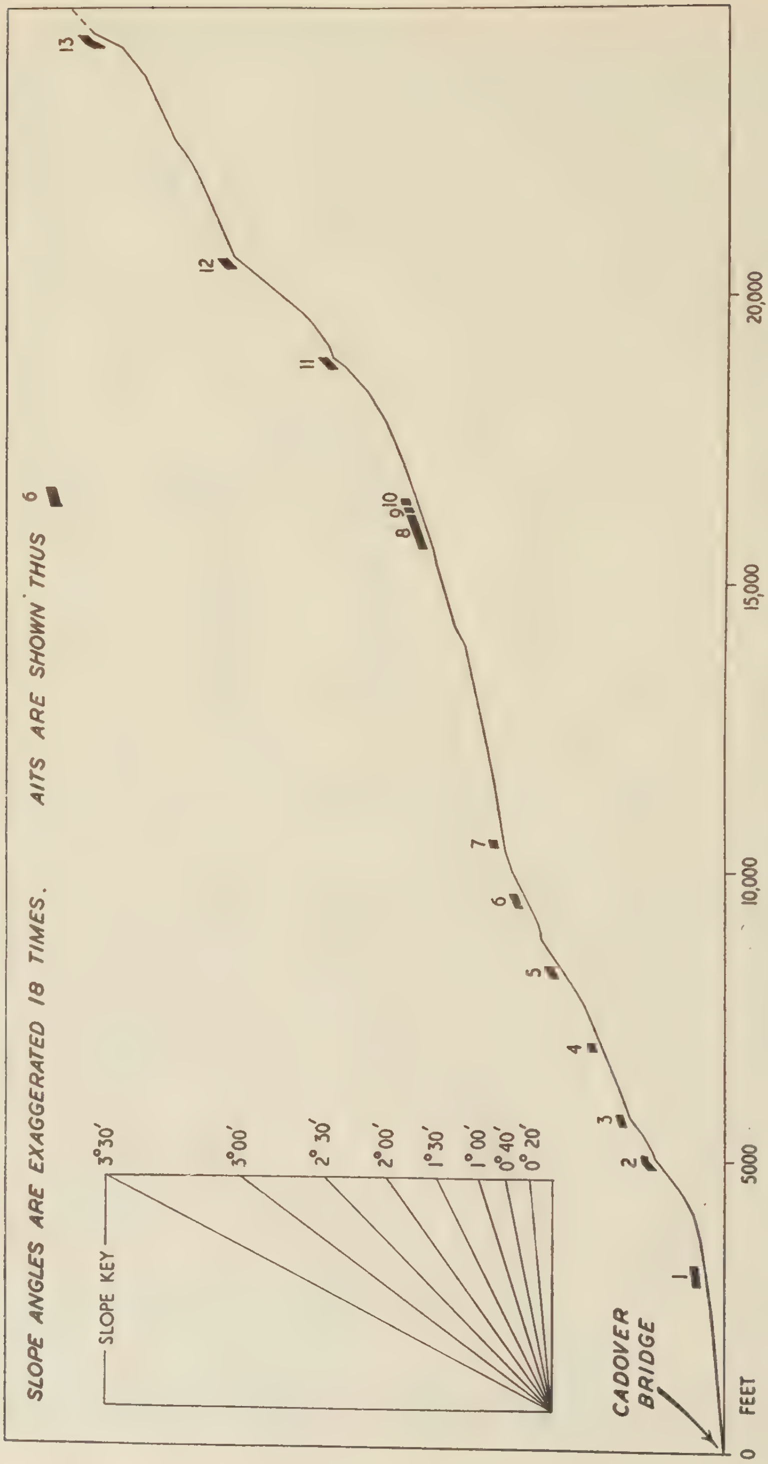


Fig. 1.—Long profile of the moorland Plym, Devon.

the inter-glacial and immediate post-glacial phases. The Plym valley above Cadover Bridge was filled with this drift which at certain points attained a thickness of at least 20 feet. This figure is a measure of the average depth of post-glacial incision on the steep reach immediately below ait No. 6 where the stream flows in a rock channel (Plate I). Elsewhere the incision is smaller, averaging 6 to 10 feet on the flatter reaches and 12 to 15 feet on the intervening steeper sections. No water-worn gravel remains on the steeper sections, but the rock floor is normally covered with from $1\frac{1}{2}$ to 2 feet of angular bouldery gravel and a thin veneer of fine alluvium (silt or inundation mud). On the other hand, 2 to 3 feet of rounded gravels capped with up to $1\frac{1}{2}$ feet of silt have been observed on the lowest portions of the concave valley segments which have not been "tinned." Both types of superficial deposit are sufficiently permeable to permit aits to develop, but, although at the present time aits built of angular boulders are more numerous on the Plym than those composed of smaller water-worn pebbles, it is considered that many aits originated with coverings of river gravel and fine alluvium which were subsequently removed.

From a consideration of the evidence provided by examples on the moorland Plym an explanation of the origin and evolution of this type of ait may be advanced. The suggested hypothesis depends on the acceptance of one very important assumption, namely, that all breaks of slope on a stream tend to be perpetuated and propagated headwards. There would seem to be no doubt as to the validity of this assumption if we are prepared to accept G. K. Gilbert's classic dictum that "erosion is most rapid where the slope is steepest."[5] It must surely follow from this principle that the increased vertical corrasion on the relatively steep reach below a break of slope would cause that reach to migrate upstream. But it is not only on theoretical grounds that the assumption would appear to be valid; von Engeln has adduced convincing evidence of headward propagation of breaks of slope in the gorge of Cascadilla Creek at Ithaca, New York[6]. It is therefore not unreasonable to assume that the short and relatively steep ungraded reaches on the streams of southern and western Dartmoor are progressing steadily headwards.

The breaks of slope on all these streams are composite; each comprises at least two fairly distinct elements—an upper knick cut in the gravel of the stream bed and a lower knick on the rock floor (Fig. 2). Green drew attention to the presence of such complex knicks on the gravel-covered valley floor of the Test[7] and his explanation of their formation on this stream of lowland England is supported by that given by King for the initiation of the very large composite breaks of slope observed on the longitudinal profiles of many rivers in southern

---

[5] G. K. Gilbert, *Geology of the Henry Mountains*, 1877, p. 102.

[6] O. D. von Engeln, "A Particular Case of Knickpunkte," *Ann. Assoc. Amer. Geogr.*, vol. 30, 1940, pp. 268–271.

[7] J. F. N. Green and K. C. Boswell, *op. cit.*

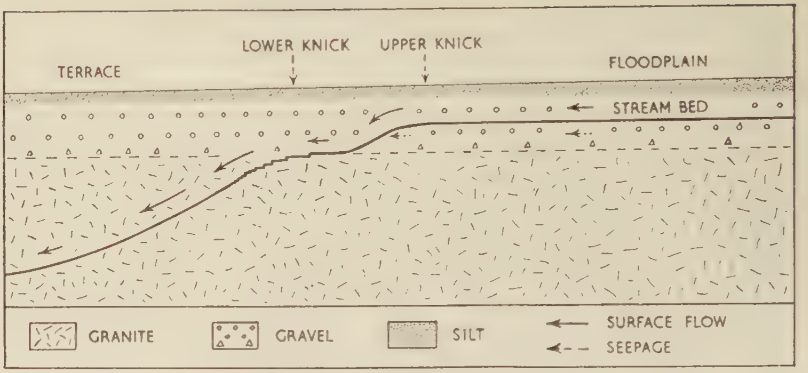


Fig. 2.—A composite knick.

Africa. According to King, "where nickpoints, in travelling upstream, encounter a resistant formation which does not reach to the top of the nickpoint itself, that nickpoint is split into two portions: an upper and a lower, the former of which extends faster and farther upstream than the latter."[8] Where the superficial layer is significantly less resistant than the rock floor, as it is in the Dartmoor valleys where permeable alluvium rests on granite, a double knick will be formed. On the Plym the lower element of the double knick may itself be composite on account of the horizontal divisional planes in the granite (Plate III).

It is at the upper knick that the ait originates. It appears to owe its inception partly to erosion under flood conditions and partly to sub-surface sapping. The valley gravels carry a considerable volume of ground water. As in all floodplains the surface slope of this saturated layer is at every point related to the water level in the stream and the degree of permeability of the gravel. Its down valley slope is increased significantly where an ascending complex knick on a winding stream reaches the lower limit of an incipient or, better still, a developed meander. At such a point an increased volume of water enters the gravel from the curved channel and follows a more direct, and steeper, course to rejoin the stream below the upper knick. It is conceivable that this increased sub-surface flow encourages ait formation in two ways. First, by washing finer material from the gravel it allows the floodplain to settle thereby producing a slight depression of its surface which is most marked where the flow is greatest. This depression across the bend or meander tends to be used during periods of high water and as a consequence may be deepened. Secondly, as the water emerges to join the stream below the upper knick it erodes the gravel bank by a process akin to spring sapping and thus begins to cut a new stream channel[9]. This develops

---

[8] L. C. King, "Landscape Study in Southern Africa," *Proc. Geol. Soc., South Africa*, vol. 50, 1947, pp. xxiii–lii.

[9] A process of this kind has also been observed by G. T. McKay on the bends of the River Mole in Surrey; see "The Process of Meandering," *Proc. and Trans. Croydon Nat. Hist. and Sci. Soc.*, vol. IX, 1923, p. 121 and text figure III.

ate I.

ate II. See fig. 3.

ate III.

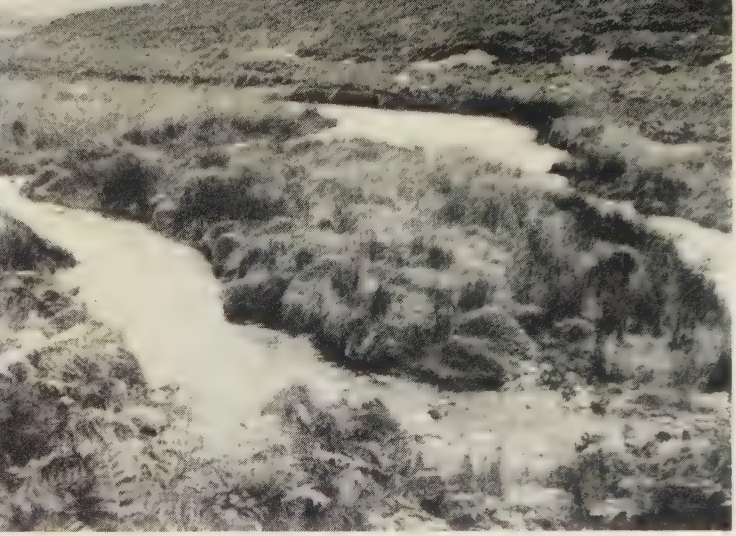


Plate IV. Ait No. 7-
A newly formed ait

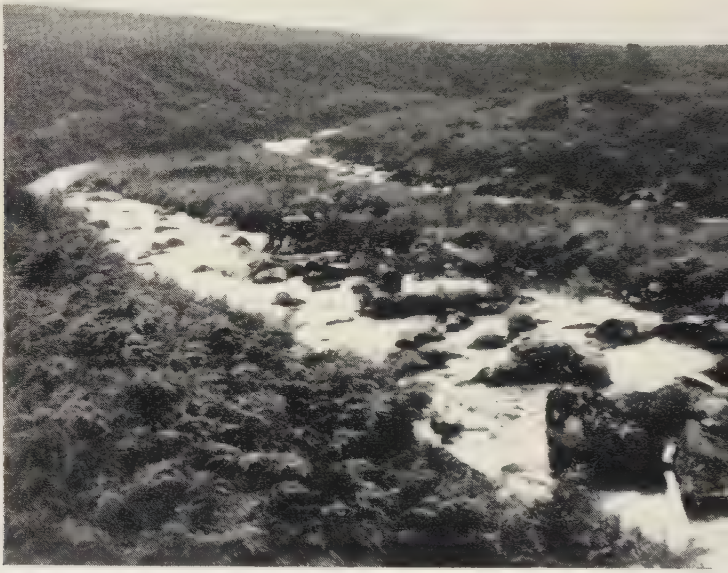


Plate V. Ait No. 6—
Intermediate stage of
development.

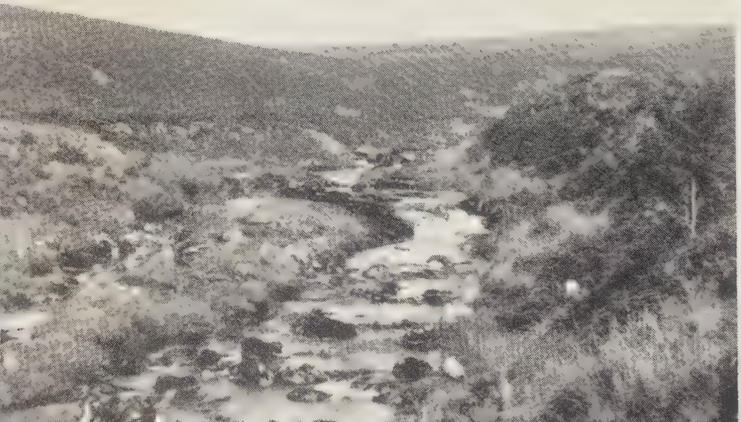


Plate VI. Ait No. 5
A rock ait.

by headward erosion as shown in Fig. 3. Even during periods of low water this process, once it has been started, is rarely inactive because at such times underground water movement continues while the main channel is dry (Plate II).

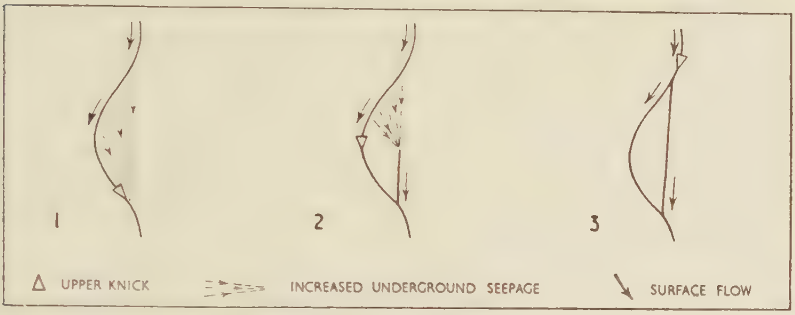


Fig. 3.—Ait development.

Ait No. 7 (Plate IV) exhibits features attributable to a newly formed ait (c.f. Fig. 4 (i)). It lies at the head of an ungraded reach and its longitudinal slope is identical with that of the floodplain above. But the presence of the upper knick in the stream is betrayed by the disturbed surface of the water, therefore the ait marks the beginning of a terrace. It is built of angular boulders overlain with rounded river gravels and capped with fine alluvium, and in outline it shows one relatively straight and one strongly curved side. In every respect, therefore, it appears as a recently detached portion of the well-developed floodplain which extends upstream of it for over a mile. On the other hand ait No. 3, which in respect of its position in relation to the break of slope also falls in class I, appears to be in a state of arrested development. Its straight channel has never developed completely and is now characterised by pools of water standing amidst mosses and rushes. Seepage takes place from the main stream to the vegetated channel but only during times of flood does the cut-off channel carry surface drainage. At other times its grass covered, upper (intake) portion is as dry as the adjoining fragmentary floodplain. Its arrested development may be due to its location on the inside of a sharp bend.

As a result of the continued headward recession of the knick and the consequent steepening of the stream gradient on both sides of the ait the surface of the latter increases its downvalley slope, which gradually diverges from that of the floodplain above and comes to lie approximately parallel with that of the stream itself (Fig. 4 (ii)). In other words, an ait in class II can be regarded no longer as a dissected portion of the floodplain above the knick (i.e., as a terrace) but as a part of the " temporary floodplain "[10] that is developing below the break of slope. Owing to the fact that the lowest portion of the ait is the first to sag or tilt downwards, apparently because of the removal of gravel from beneath the vegetated alluvial capping, it may exhibit a slight but distinct break of slope on the surface (e.g., ait No. 2) or its longitudinal profile may be convex (e.g., ait No. 13). Thus the changed attitude is accompanied by and indeed the immediate consequence of the disintegration of the original ait whose surface is successively lowered by erosion at the edge, particularly during periods of high water, until it is level with, or a few inches below, the temporary floodplain. By this means most of the aits on the steep reaches of the Plym have been stripped of their original cover of well-rounded river gravels: therefore, like ait No. 6 (actually at the foot of a steep reach), they are composed of angular boulders of various sizes resting on a granite base and covered with approximately 8 inches of silt (Plate V).

---

[10] This useful term is borrowed from Green and Boswell, *op. cit.*, p. 115.

As long as the downward cutting associated with the recession of the complex knick continues so long does the surface of the ait continue to be lowered. Indeed, the process will operate at an increased rate as the lower element of the double knick (the rock knick) passes upstream until the entire superficial cover may be removed and a rock ait formed (Fig. 4 (iii)). Ait No. 5 has reached this stage (class III). The greater part of its surface consists of bare rock, but its lower end is covered with boulders and alluvium and is vegetated. The slack water in its lee may indeed encourage temporary deposition of alluvium. The rapids at its upper end are typical of those sections of the stream which flow in a rock channel in the well-jointed, pseudo-bedded granite (Plate VI).

The subsequent disappearance of this particular kind of ait must be attributed to lateral erosion and aggradation. Provided the rate of recession of the break of slope at the lower termination of the concave segment on which it lies is no greater than that of the knick which brought it into being, it is conceivable that it will, without experiencing any rejuvenation, be buried under alluvium. After that portion of the concave segment in which vertical corrasion is significantly greater than lateral corrasion has passed the ait the latter is doomed to disappear with the development of the floodplain[11]. Ait No. 4, which lies on a relatively well-graded reach to-day, appears to have reached the penultimate stage. The river has forsaken its original curved course for the straight cut-off channel and the former, carrying a small volume of water only, is overgrown with rushes.

Thus the process responsible for the disappearance of this type of ait—lateral erosion and its accompanying deposition—is also responsible for the appearance, ephemeral though it may be, of the true shoal. Both features are called aits in ordinary speech, but their respective origins and developments are quite dissimilar.

---

[11] The presence of gravel "aits" partly buried under recent alluvium on the lower Thames floodplain has been noted by W. B. R. King and K. P. Oakley; see "The Pleistocene Succession in the lower part of the Thames Valley," *Proc. Prehist. Soc.*, vol. 2, 1936, p. 68.

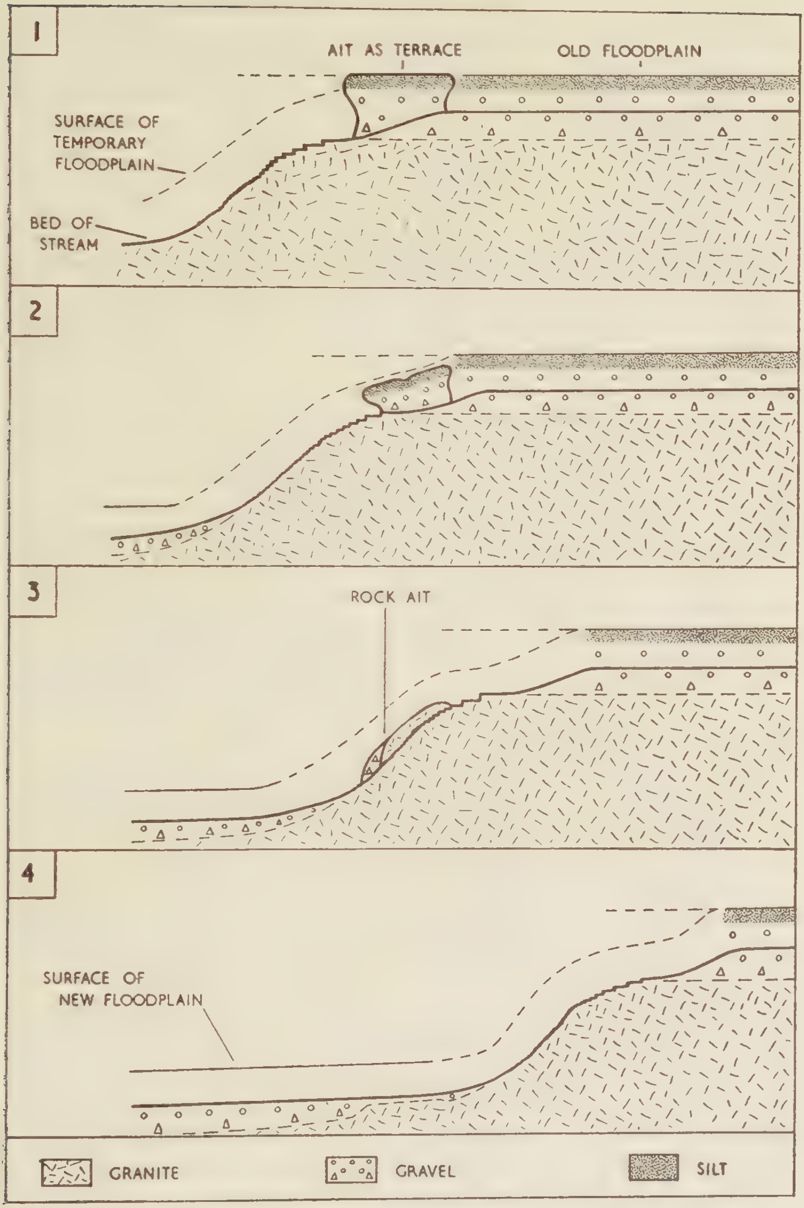


Fig. 4.—Stages of ait development.
N.B.—Length of ait and vertical scale are greatly exaggerated.

The origin and development of shoals are common knowledge: they were mentioned by Lyell in 1863[12]. In his discussion of alluviation and floodplain development the following sentences occur: "As a rule, when a river attacks and undermines one bank, it throws down

---

[12] C. Lyell, *The Antiquity of Man*, 4th ed., London, 1863, pp. 173–174.

gravel and sand on the opposite side of its channel, which is growing somewhere shallower, and is soon destined to be raised so high as to form an addition to the alluvial plain, and to be only occasionally inundated . . . Sometimes an island is formed in midstream, the current flowing for a while on both sides of it, and at length scooping out a deeper channel on one side so as to leave the other to be gradually filled up during freshets and afterwards elevated by inundation mud or 'brick-earth.'" Shoals are features restricted to those valley segments in which lateral corrasion is predominant. They are common concomitants of developing floodplains, but they are short-lived elements of a valley landscape. Their independent existence is cut short by the restless cross-valley migration of the mature stream which gave them birth; their identity is lost in that of the developed floodplain.

The type of ait which has been studied on the streams of Dartmoor and to which the late J. F. N. Green was the first to draw attention may be termed an erosion-ait to distinguish it from the shoal-ait so characteristic of mature and post-mature stream segments. The main conclusions to be drawn in respect of the origin and characteristics of erosion-aits are as follows :—

(1) they are erosional features of recent origin which may be expected to pass through definite stages of development ;
(2) they come into being as remnants of one floodplain or incipient floodplain (i.e. as terraces) which is being destroyed and pass out of existence beneath another which is in course of construction ;
(3) they appear to be typical of youthful ungraded reaches, that may or may not be due to rejuvenation, which separate more mature valley segments ;
(4) they are diagnostic of active headward erosion (i.e. of vertical corrasion) in an alluviated valley floor ;
(5) their relative age may be ascertained from (*a*) their constitution, and (*b*) their position in relation to the break of slope—the upper knick ;
(6) their size is related to the amplitude of the incipient or developed meanders on the graded reach above the knick.

Although an ait, or river island, may originate as a shoal or a terrace fragment, and although both are expectable phenomena whose formation is a direct result of normal processes of valley development, it is submitted that the erosion-ait is the one most commonly encountered[13] and a correct appreciation of its significance can aid the recognition and interpretation of complex knicks in a polycyclic river valley.

---

[13] All the aits which Green observed on the Test were found to be fragments of terraces (Green and Boswell, *op. cit.*, p. 115): even those on the Thames between Maidenhead and Marlow are erosion-aits associated with the Marlow knickpoint (J. F. N. Green, *Proc. Geol. Assoc.*, vol. 59, 1948, p. 179). Temporary "accidental" features which may arise from the accumulation of material in the lee of fallen trees or other obstacles are not here regarded as aits.

# A NOTE ON THE TWENTY-FIVE FOOT "CONTOURS" SHOWN ON THE ORDNANCE SURVEY 1:25,000 MAP

K. M. Clayton*

WITH the publication of the 1 : 25,000 map, the Ordnance Survey have provided a second map upon which the results of detailed geographical field work may be plotted. Hitherto, the only suitable map for this purpose has been the six-inch map, although the 1 : 2,500 (approximately 25 inches to one mile) has been used for very detailed work. The six-inch map is very nearly a plan, that is to say, it is a true-to-scale representation of features on the ground, with the exception of some streets in built-up areas which are exaggerated in width in order to allow the insertion of their names. In addition, relief is represented only by surveyed contours and heights. The 1 : 25,000 map differs from the six-inch map in many ways. Small objects such as roads have to be shown by conventional symbols of exaggerated size, so that this is a map, not a plan. The greatest difference from the six-inch map is in the representation of relief. Relief is principally shown by contours, interpolated at every twenty-five feet between the surveyed contours shown on the six-inch scale. It is important to know the limitations of the 1 : 25,000 map if it is to be used for plotting field work, and in particular for morphological field work, to know something of the validity of the interpolated contours.

Sources of information regarding O.S. maps are remarkably limited. Excellent descriptions are contained in the three O.S. handbooks[1] while the Ordnance Survey Professional Papers contain more detailed information. For the 1 : 25,000 map, details regarding the insertion of the interpolated contours were obtained from correspondence with the Ordnance Survey and the help of the Director-General and Officers in this matter is gratefully acknowledged.

Some account of the surveyed contours shown on the six-inch and smaller scales of the O.S. is first necessary. It is frequently stated that the O.S. maps show an instrumental contour at 50 feet,[2] with others at every 100 feet from 100 to 1,000 feet, and above that at every 250 feet. This is the case only in the southern counties of England and Wales and even here it is possible to find local variations. Thus on the six-inch sheet *Staffs. VIII NE*, the 1,250 ft. contour is shown, but it is omitted from the adjacent sheet, *VIII SE*. This is a survival of the former exclusion from the six-inch map of all contours not surveyed by precise levelling with spirit-level and staff. Over southern England the contours at every 250 feet above 1,000 feet were surveyed by water levelling, a far more rapid but rather less precise method. "The water level consists of two metal tubes joined together by two vertical glass cylinders . . . coloured water . . . is poured into the level and rises about half way up the glass cylinders."[3] Sighting along the two water levels gave a horizontal line of sight. The level differed fundamentally in its use from the spirit level as it was moved round the contour and no staff was employed. "It will be of interest to compare the rates and costs of instrumental and water level contouring. The former implies a party of two, observer and labourer, costs about 16s. 4d. a linear mile and goes at a rate of about 1·4 miles per day. The latter costs about 3s. a linear mile, requires but one observer and about 4 miles per day is a common output. Water levelling is not a matter of precision, but gives much better results than sketching."[3]

---

* Mr. Clayton is currently serving with H.M. Forces. His article arises from research work carried out while he was a member of staff of the Geography Department, University of Nottingham.

[1] *A Description of the Ordnance Survey Small Scale Maps.* Ordnance Survey Office, 1947.

*A Description of the Ordnance Survey Medium Scale Maps.* Ordnance Survey Office, 1947.

*A Description of the Ordnance Survey Large Scale Maps.* Ordnance Survey Office, 1947.

[2] All altitudes mentioned in this article are above Ordnance Datum.

The heights at which instrumental (and here the term is used to include both spirit and water-levelled) contours were surveyed are shown for the counties of England and Wales in Fig. 1. It is compiled from the information given by Brigadier Winterbotham in "The National Plans,"[4] and although details for Scotland have not been plotted, they may be found in his table. The areas to which the columns refer are plotted in the accompanying map. It will be seen that the "normal" sequence of surveyed contours does not apply to the six northern counties of England. This is of importance as this area contains a considerable proportion of upland Britain, and if detailed morphological work is to be carried out on the land forms of the Pennines or Lake District, it is clearly necessary to know that the surveyed contours do not occur at every 250 feet above 1,000 feet, or reliance may be incorrectly placed on interpolated rather than instrumental contours.

The production of a map on the 1 : 25,000 scale was recommended by the Davidson Committee in 1938. This committee had been formed in 1935 to resolve the crisis resulting from, first, the cuts made in the Ordnance Survey vote as part of the reduction in government expenditure, and secondly, the concurrent rapid development of the inter-war housing estates which led to the need for more frequent map revision. Its report[5] is a valuable survey of the work of the Ordnance Survey and a useful summary of the many demands made on its maps. In paragraph 44 of the report, the committee discussed the provision of contours on Ordnance Survey maps. They recommend that " an increase in the number of contours could be combined with a relaxation in the previously unnecessary high standards, and that by this means map users generally would be better served and at less cost to the state." This view had earlier been put forward by Brigadier Winterbotham in a very extensive survey of the National Plans (the 10-foot, 5-foot, 25-inch and 6-inch scales.) " In the days of the discussion of principles it was often, and correctly, stated that engineering projects could not often be designed in full details from contours. It was nevertheless assumed that if shown all contours should be spirit levelled and that it would be dangerous to show any less exact contouring on a plan. To-day for the purposes of town and regional planning there is a great demand for contours, not for any precise purpose, but to study drainage and other matters of general layout."[6]

---

[3] *Contouring with the Water Level.* Ordnance Survey, 1902.

[4] H. St. J. L. Winterbotham. "The National Plans." *Ordnance Survey Prof. Papers New Series No.* 16, H.M.S.O., 1934.

[5] *Final Report of the Departmental Committee on the Ordnance Survey* (Davidson Committee). H.M.S.O., 1938.

The Ordnance Survey decided to aim at surveying eventually all the contours on the 1 : 25,000 map, but as an interim measure to insert interpolated contours at every twenty-five feet. Initially the heights of the instrumental contours were given in the key to the map, but now, as an economy measure this key is omitted. The interpolated twenty-five foot contours are drawn in by draughtsmen with the aid of " hill-sketches " on the six inch scale. These sketches were prepared to form a basis for hachuring the third edition of the one-inch map, and were executed in the field on a six-inch map showing instrumental contours and " all the available trigonometrical points and spot heights."[7] The sketches indicate, by means of a number of lines sketched between the instrumental contours, the general formation of the land. The lines drawn were not intended to approximate to any particular contour interval for " the number of lines between any two instrumental contours will vary with the steepness of the slope."[7] Clearly these sketches will portray the relief more faithfully where the surveyed contours are only a short distance apart, but in extreme cases they must be very unsatisfactory. Thus in Cumberland above 2,000 feet, the surveyed contours are 500 feet apart, and the accuracy of the interpolated twenty-five foot contours must be very low. Such errors are inevitable until more contours can be surveyed, but the lack of a separate symbol for surveyed contours on the 1 : 25,000 map means that these errors often pass unnoticed.

The interpolated contours also contain many avoidable errors, for in their compilation the large number of altitudes shown on the first edition of the six-inch map but not on the current edition were omitted. To quote a single example, on the O.S. 1 : 25,000 map, sheet 43/25 (Wirksworth, Derbyshire), the trigonometrical point at 294528 lies between the 750 ft. and 775 ft. contours. No height is given for the trigonometrical point of the current six-inch sheet for the same area, *Derbyshire XXXIX NW*, but the first edition gives a value of 783·5 ft.,

---

[6] *Contouring with the Water Level,* q.v.

[7] Personal correspondence with the Ordnance Survey.

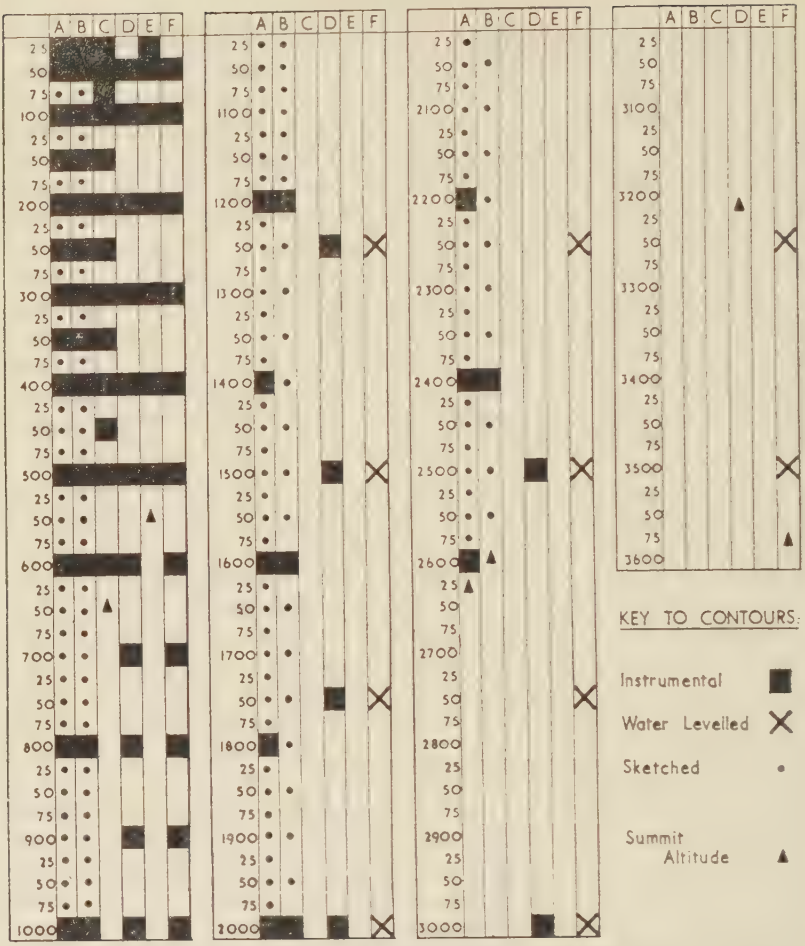


Fig. 1.—Analysis of the heights at which contours were surveyed or sketched in the counties of England and Wales. The counties are listed in the six categories, A, B, C, D, E and F, whose extent is shown in Fig. 2.

indicating an appreciable error in the 1 : 25,000 contours. Further to complicate the position, "certain additional heights were supplied" (to the hill sketchers) "to facilitate a more accurate representation of the form lines."[8] These additional heights were either inserted from existing records or were established in the field for the purpose. As they may occur at critical points such as spur flats between instrumental contours, they greatly increase the wide range in accuracy that is characteristic of the representation of relief on the 1 : 25,000 map.

In any case, the decision to curtail the number of heights shown on the six-inch map is to be regretted. The heights are admittedly very unevenly distributed on the first edition of the six-inch map, and this appears to have been an important factor in the decision.

---

[8] Personal correspondence with the Ordnance Survey.

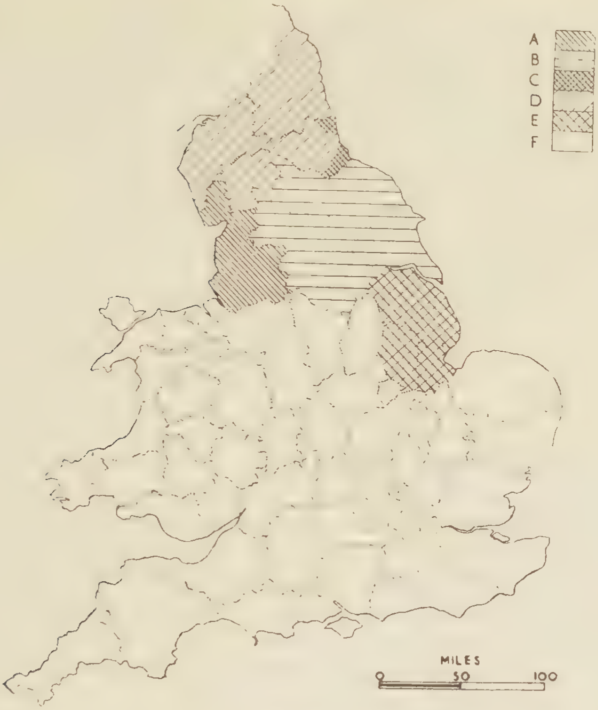


Fig. 2.

but the increase in uniformity must be set against the considerable loss of information. The present six-inch map shows "only one" (spot height or bench mark) "in every ten chains"[9] or eight per mile, rather less than half the total number shown on the first edition. An analysis of two six-inch maps, one in an upland area ranging between 600 and over 1,000 feet, the other in part of the Trent floodplain between 95 and 117 feet, bears this out.

| | Edition | Trig. Points | Spot hts. | Bench Marks | TOTAL | % of First |
|---|---|---|---|---|---|---|
| Upland Area .. .. | First | 3 | 103 | 67 | 173 | |
| *Derby XXXII S.E.* | Current | 0 | 21 | 55 | 76 | 44% |
| Lowland area.. .. | First | 2 | 96 | 24 | 122 | |
| *Derby LVI S.E.* .. | Current | 1 | 29 | 26 | 56 | 46% |

The lack of information on the precision of the interpolated contours shown on O.S. maps, not only at the 1 : 25,000 scale but also on the one-inch, has given rise to a volume of uninformed criticism about the results of morphological work making use of the published maps of the Ordnance Survey. This is most vehemently put by R. J. Russell in the course of a bitter attack on what he calls the cult of

---

[9] Personal correspondence with the Ordnance Survey.

" pure " morphology. He asserts that " in England . . . the pure morphologist has maps little better than we had for Montana or Wyoming prior to 1920."[10] This outrageous statement is not substantiated by field-work with the 1 : 25,000 map. An alternative approach is provided by the mathematical analysis of H. A. L. Shewell[11]. In a rather complex paper he examines the error involved in estimating the height of any given point, and demonstrates the superiority of closely spaced and fairly accurate contours over contours which have been precisely levelled but are more widely spaced apart. " Thus if a 1 : 25,000 map is contoured at 25 ft. with a standard error of 6 ft. or at every 50 ft. with a standard error of 2 ft., the random height error from the first method is 6·8 feet, while that from the second is 8·4 feet, an increase in error of 24 per cent. over the cheaper method. The argument is reinforced by taking into account the improved representation of the shape of the ground which would be given by the more numerous contours."

Field work involving mapping breaks of slope on the 1 : 25,000 scale has revealed an interesting point regarding the contouring. It soon became apparent that while extremely serious errors could be found regarding the location of the twenty-five foot contours, they very frequently follow breaks of slope and thus emphasise the form of the ground in an effective manner. This would seem to be the direct result of basing these interpolated contours on hill sketches which would naturally emphasise the breaks of slope. On steeper slopes there is a tendency for the contours to be spaced at an even distance apart, while gentle slopes tend to be sharply differentiated into their constituent facets, with the interpolated contours following the breaks of slope between these facets. In other words the interpolated contours tend to caricature genuine characteristics of the form of the ground.

Fixing altitudes from the 1 : 25,000 map alone is, as we have seen, highly unsatisfactory even when the heights of the instrumental contours are known. In morphological work increasing use is being made of instruments such as the aneroid to determine altitudes,[12] but these depend on the use of fixed heights shown on the map, and if the 1 : 25,000 is to be used they must be transferred from the six-inch map. In field work without an instrument or in cartometric analysis, altitudes may only be based on surveyed contours and consequently it is not possible to establish a series of surfaces by such a method where these lie closer together than the instrumental contours. Where the features are separated by a greater interval than that between the instrumental contours, it should be possible to rely on the 1 : 25,000 map alone. In time the replacement of the present interpolated contours by contours surveyed with an accuracy similar to that given by water-levelling will provide geographers in this country with an unrivalled topographical map. In the meantime it is to be hoped that the Ordnance Survey may pay more attention to the documentation of the 1 : 25,000 map by providing a symbol for instrumental contours, and by increasing the number of spot heights shown.

---

[10] R. J. Russell. " Geographical Geomorphology " (Presidential Address). *Ann. Assoc. American Geographers*, vol. XXXIX, No. 1, Mar., 1949, pp. 1–11.

[11] H. A. L. Shewell. " The Accuracy of Contours." *Journ. Roy. Inst. Chartered Surveyors*, vol. XXXI, 1951.

[12] R. F. Peel. " Geomorphological Field Work with the Aid of Ordnance Survey Maps." *Geogr. Journ.*, vol. CXIV, 1949, pp. 71–75.

# CARINTHIA

## A Province of Austria's Southern Frontier

ALICE F. A. MUTTON*

THE province of Carinthia (Ger. Kärnten) extends from the snow-capped peaks of the Austrian High Alps (the eastern portion of the Hohe Tauern group) in the northwest, and from the eastern Dolomites in the west, to the intensively farmed lake basin of Villach-Klagenfurt and the Drau lowlands in the southeast. The mountainous framework of the province is completed by the Noric Alps on the border of Styria to the northeast, and by the Carnic and Karawanken Alps to the south where they form the frontiers with Italy and Yugoslavia respectively.

Carinthia forms a passage land in the southeastern Alps, crossed by international routeways from Mediterranean Europe to the Danubian lands and from the upper Rhine basin, Switzerland and southern Germany to the Balkans. The two foci of this network are Villach and Klagenfurt (Fig. 1), both important centres of railway communication, as they have been the destination of overland routes converging on the Drau lowlands from the Alpine passes and from the Adriatic coastlands since Roman times. From the west, the so-called Orient Express route enters Austria through the Arlberg tunnel, to be joined by that from Munich and south Germany at Innsbruck. As the railway leaves the Salzach valley for the steep climb over the Klamm pass to the Hohe Tauern tunnel, it is joined by that from Salzburg. The divide is crossed at 3,675 ft. by means of a tunnel 5½ miles long, the line then approaching the Möll valley which it descends by following the terrace high on its northern slope, and so to Villach. From Venice and Udine the modern route utilises the Tarvisio or Tarvis[1] gap, while a railway also links Trieste and Ljubljana (Laibach) with Klagenfurt, by means of a tunnel through the Karawanken Alps. From Belgrade the railway follows the Drau

---

* Dr. Mutton is Senior Lecturer in the Department of Geography, Queen Mary College, University of London. She wishes to thank the College for a grant from its Research and Publications Fund towards the cost of the illustrations and Miss E. Harvey for help with the maps.

[1] Alternative place names are given where both are in current use. In instances such as this, the German form is a survival of the period of the Dual Monarchy.

(Drava) valley almost throughout. Lastly, the Semmering pass and the Mur valley link Vienna with Klagenfurt and southern Carinthia. Traffic by other routes is mostly by road, although there is a line from Klagenfurt and Villach following the Drau valley through the "Tirolean Gate" below Lienz to the Pustertal and Italian Tirol. In the Gail valley, the railway stops at Kötschach, north of Mauthen, although a road provides a route over the "Carinthian Gate" to the Pustertal and Italian Tirol.

It is not proposed to recount in detail the chequered political history of Carinthia. It is sufficient to stress the fact that to-day 96 per cent. of the population is German-speaking, the rest Slovene. However, just over 30 years ago, at the time of the Treaty of St. Germain-en-Laye, when national consciousness was rampant in this part of Europe, the number of Slovenes living in the Drau lowlands justified the creation of two plebiscite districts, one in the Klagenfurt region and another to the south, in the Rosental district. The southern region voted for incorporation in Austria and so the Klagenfurt region was included automatically.[2] The frontier established with Carniola in 1920 is marked by a commemorative stone on the summit of the Loibl pass in the Karawanken Alps. Dual place names still persist on both sides of the frontier and Slovene influence may be traced in the dispersed type of farm settlement and in the style of farm buildings, etc. To-day, there is little contact across the Yugoslav frontier, though more with Italy.

## LANDSCAPE

Carinthia is a province of marked diversity, although the fundamental contrast is between the Alpine ranges and the river lowlands and lake basins within the mountain framework. To the northwest, the Austrian Alps rise to their culminating point in the Gross Glockner at 12,440 ft., with the Pasterze glacier lying on its north-eastern slope (Plate I). The other Alpine ranges attain only half this height and they are frequently forested almost to the sky line, which is often relatively level compared with the arêtes of the Hohe Tauern. The so-called Drau ranges of southern Carinthia, including the Gailtal, Carnic and Karawanken Alps, have a marked east-west general trend (Fig. 3). To the east the lowlands and lake basins of the Villach-Klagenfurt region, lying at about 1,500 ft. drain eastwards as part of the Drau basin. Beyond them two subsidiary ranges assume a direction at right angles to the general trend. The wide trench of the southward flowing Lavant is bounded by two ridges which branch off from the Lavanttaler Alps, namely the Sau and the Kor Alps, the crest of the latter forming the provincial boundary with Styria. The steep western slope of the Kor Alps is the result of erosion along a line of faulting[3]; their granitic rocks are continued south-westwards in a wide sweep towards the Karawanken

---

[2] I. Bowman. *The New World*, London, 1922, p. 207–211.

[3] N. Krebs, *Die Ostalpen u. das Heutige Osterreich*, vol. 2, Stuttgart, 1928, p. 212.

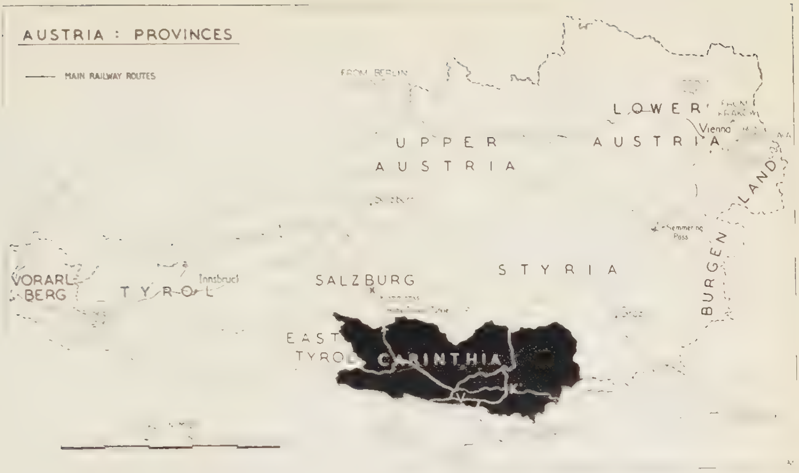


Fig. 1.

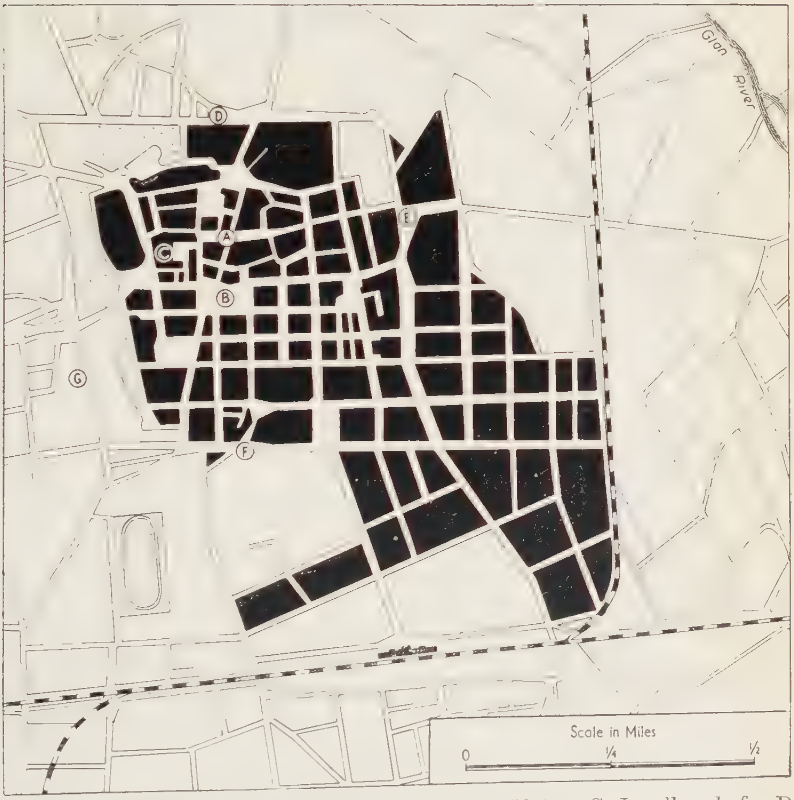


Fig. 2.—Klagenfurt. A, Alter Platz; B, Neuer Platz; C, Landhaushof; D, St. Veiter Ring; E, Völkermarkter Ring; F, Viktringer Ring; G, Villacher Ring.

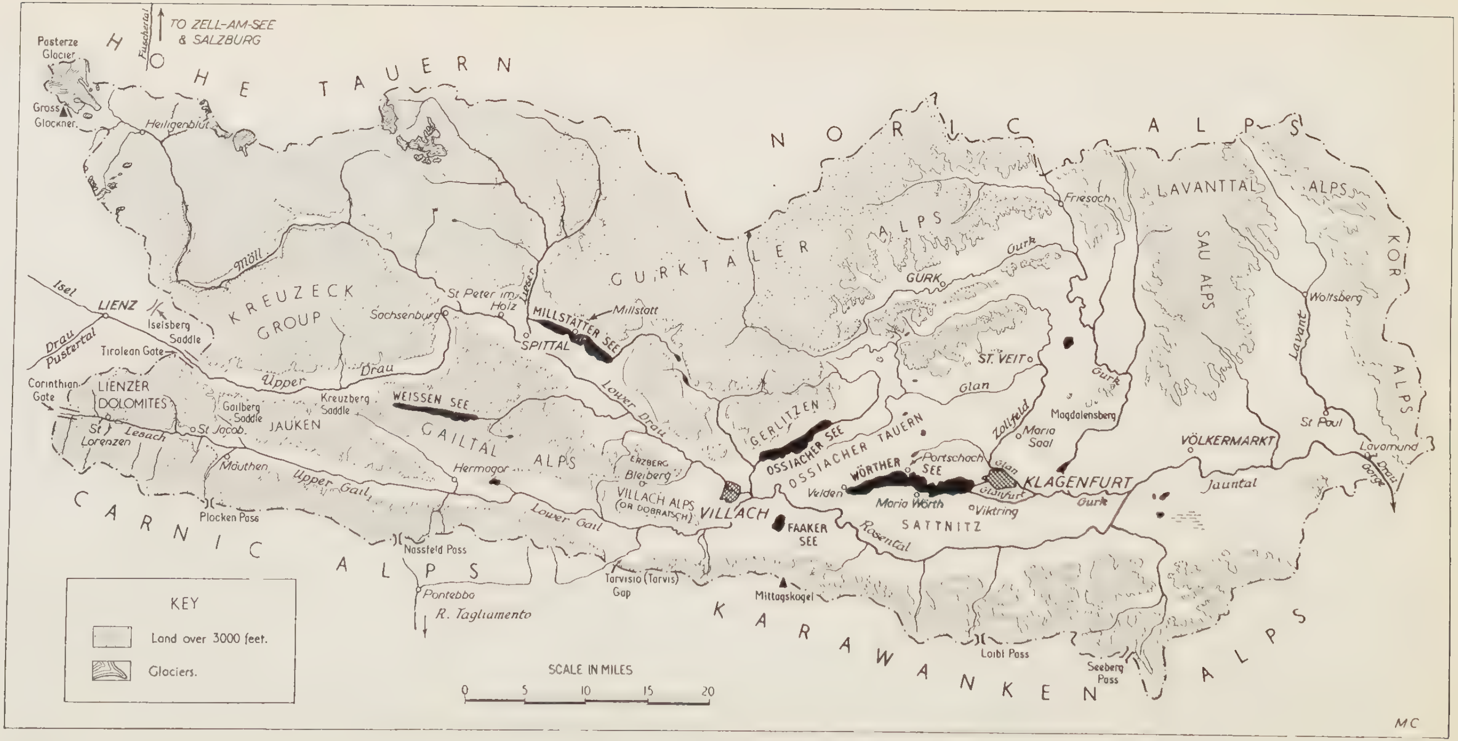


Fig. 3.—Carinthia, index map.

Range and here the Drau has carved an impressive defile through the structural barrier, thus forming an " Iron Gate " feature in miniature. This " bottle neck " in the Drau drainage is held to have been partly responsible for the ponding back of the drainage in Pliocene times ; hence the thick spread of lacustrine deposits on the floor of the Klagenfurt basin.

At the time of the maximum advance of the Pleistocene ice, the great valley glaciers of the Drau and the Gail advanced from the west to cover the Klagenfurt basin and to coalesce east of it, the limit of the lowlands (Würm) ice corresponding almost exactly with the rim of the basin to the north and east. With the retreat of the ice towards the Alps, moraines were left around St. Veit and Völkermarkt and the soils of the basin were further varied by local deposits of loess. In the Alpine regions of Carinthia, the erosive action of ice has done much to sharpen the landscape features, though the relief was already strong. Much of the beauty of southern Carinthia indeed arises from the harmony of glacial and mountain lake scenery. The four large " finger " lakes, those of Millstatt, Weiss, Ossiach and Wörth, are of special interest, as none lies in a main valley. All appear to occupy troughs eroded by diffluent branches of the main Drau glacier, and their drainage is blocked by terminal moraines or by fluvio-glacial gravel fans. The remote Weissen See, imbedded in the Gailtal Alps west of Villach, is only 3 miles from the Drau valley at its western end, yet it drains eastwards in a direction suggesting a former high level course of the Drau. The ice that eroded the trench clearly poured into it from the main Drau glacier over the col (3,180 ft. high) at the valley head just beyond the lake. Lake level is 2,790 ft. and the water 300 ft. deep at the lower end. Again, the Millstatt lake lies at 1,700 ft. in a trough parallel to the Drau valley but separated from it at its western end by a series of fluvio-glacial gravel fans built up by the Lieser. There is no exit eastwards however and the outlet of the lake is by means of a cut through these gravels to the Lieser. North-east of Villach, a valley, once followed by part of the Drau glacier, holds the Ossiach lake between the Gerlitzen massif and the Ossiacher Tauern, while the Wörther See, 10 miles long and 1¼ miles wide, with a depth of 277 ft., extends in a west–east direction from the lake-side resort of Velden to the outskirts of Klagenfurt. This lake (Plate II), with its fretted shores, wooded peninsulas and islands, and its intense blue waters, enjoys remarkably hot summers, the water recording a maximum daily temperature in July and August of over 80° F., though opposite extremes are reached in winter, the mean daily minimum (34° F.) being recorded in February. In the neighbourhood of the lakes, as well as in some of the Alpine valleys, temperature inversion is commonly experienced, especially after cold still nights in late autumn and winter, when heavy mists may lie around the lakes in the early morning as well as filling in the valleys, The lake-side resorts of Velden and Pörtschach, on the Wörther See, about 1,320 ft. above sea level, and also Millstatt, on the lake of that name, have mainly a summer season ; very few hotels remain open all the year. There is insufficient ice on the lakes, or snowfall at this relatively low level, to make possible a winter sports industry as in the Hohe Tauern.

In summer, the Alpine scenery of the Hohe Tauern has been made accessible to the tourist since the Gross Glockner road was completed just before the recent war. The highway, an engineering feat of a high order, provides a spectacular summer route across the Hohe Tauern. Two roads take off from Heiligenblut, in the Möll valley, one leading by a series of hairpin bends over the Hochtor pass, 8,432 ft., to the Fuschertal, on the Salzburg side of the massif, and so to the Salzach valley and Zell-am-See. The other ascends at the Franz Josef hotel at over 7,900 ft., from which superb views may be had over the Pasterze glacier to the Gross Glockner, although in summer the summit is frequently enveloped in cloud. Below, the church spire of Heiligenblut rises in sympathetic repetition of the pyramidal peak of the Gross Glockner which dominates the valley (Plate I). During the winter of 1951–2, the village suffered severely from avalanches. Heiligenblut lies just below the point where several Alpine torrents converge on the Möll ; one of these, the Leiter, which flows from the Margaritze cirque lake at the head of the valley, is at present involved in diversion by means of a tunnel designed to convey water to the Mooserboden reservoir at the head of the Kaprun valley, on the northern side of the Gross Glockner, as part of the Glockner-Kaprun hydro-electric project.[4]

The Hohe Tauern massif, the region of maximum relief in the Eastern Alps, represents the exposure of deep-lying Pennine " nappe " structures, by the removal of an area of the later " Austride " folds ; through the " window " thus formed we can see the highly resistant older rocks, intensely folded and eroded, just as is the case with the Lower Engadine " window " in the upper Inn valley[5]. The mountains may be compared with the High Alps of Switzerland on account of their rugged grandeur, their arêtes, rock precipices and bare peaks. On the other hand, the Drau ranges are much less spectacular. They are carved from rocks involved in the " Austride " folding and their form is not so complex. The scenery is glaciated and rugged in places, but fir forests mantle the greater part of the slopes (Plate III). In southwest Carinthia, the limestone folds of the East Tirol are continued across the provincial boundary into the Lienzer Dolomites, rising to a maximum of 8,990 ft., between the Lesachtal (upper Gail valley) and the Pustertal (upper Drau valley). These mountains are divided from the Gailtaler Alps by the Gailberg saddle, providing a route, at a summit level of 3,222 ft., between the Gail and the Drau valleys. The col owes its relatively low height, like that of others in western Carinthia, to the fact that it has been overridden by ice. To the east lies the triangular block of the Gailtaler Alps, rising to 7,285 ft.

---

[4] Described in Mr. Cole's article on pp. 93–100 of this issue. See also A. F. A. Mutton. " The Glockner-Kaprun Hydro-electric Project, Hohe Tauern, Austria," *Geographical Review*, vol. 41, 1951, pp. 332–334.

[5] E. Bailey, *Tectonic Essays, mainly Alpine*, Oxford, 1935, p. 134.

in the Jauken. To the southeast, the Erzberg and the Villacher Alps form subsidiary ranges. An alternative Slovene name for the latter is the Dobratsch, and a popular one, owing to the accessibility of the peak from Villach, which it dominates, "the Rigi of Carinthia." The southern slopes of the Dobratsch are noted for their landslides, which at times impede drainage in the Gail valley. On the northern side, lies the enclosed and relatively sunless Bleibergtal, with its lead, zinc and iron mines. The centre of the mining industry, as the name suggests, is the township of Bleiberg.

In contrast with the relief of inner Carinthia, the frontier ranges of the Carnic and Karawanken Alps are narrow and spine-like, sloping steeply northwards, without foothills. The Carnic Alps extend for a total distance of over 60 miles from west to east along the Italian frontier, about 37 being in Carinthia. The range is seldom more than 9 miles wide and its general height is about 6,500 ft. In the west, schists and slates give rise to fairly smooth though steep slopes, with arêtes and occasional cirque lakes occurring above the zone of alpine pastures. The range forms the water-shed between streams draining to the North Italian plain by the Tagliamento system and to the Danube by the Drau and Gail. The many streams carving deep valleys on the northern slope of the Carnic Alps contrast with the relative absence of surface drainage on the limestone slopes of the Lienzer Dolomites and the Dobratsch, on the opposite side of the Gail valley. As the result of ice erosion, comparatively low saddles provide routes across the Carnic Alps and these have been in use since pre-Roman times. The two passes which are followed by modern roads are the Plöcken, at 4,462 ft., and the Nassfeld, at 5,085 ft., both leading to Pontebba, in Friuli, and so to Venice. To the east, a water gap between the Carnic and Karawanken Alps provides a more frequented route, followed by road and railway, between Villach, Tarvisio (Tarvis) and Pontebba, and so again to Udine and Venice.

The Karawanken Alps continue the trend of the Carnic Alps. Metamorphic rocks are found immediately east of the Tarvisio gap, but farther east they are replaced by highly folded Triassic limestones, forming narrow ridges and great rock buttresses. The valleys are short and steep, the slopes being thickly covered with magnificent stands of beech, with firs ascending to the summit. Waterfalls cascade into the ravine-like valleys, a fine example occurring on the route to the Loibl pass. This pass (4,463 ft.) was known to the Romans and has been in use since the middle ages, a hospice being built for the shelter of travellers and a road constructed over the pass in the 15th century. In modern times, traffic has declined since the piercing of the 5-mile-long Karawanken tunnel to the west of the pass. This carries the railway from Villach and Klagenfurt to Ljubljana (Laibach) and Trieste, but to-day the traffic across the frontier between Yugoslavia and Austria is negligible. Another pass lies in the eastern part of the range, namely, the Seeberg, at 5,650 ft. It is followed by a modern road which ascends from the Jauntal (Drau valley) at Völkermarkt and descends to Kranj in the Sava valley in Carniola and so to Ljubljana.

The valley lowlands of Carinthia extend from west to east in sympathy with the " Drau " trend of the adjacent Alpine fold ranges. The main streams are those of the Drau and its tributaries, the Gail and the Möll. In the south, the somewhat remote valley of the Gail leads directly from East Tirol *via* Hermagor to Villach, by the straightest longitudinal valley in the eastern Alps. At its head a 5,000 ft. col, known as the Carinthian Gate, provides access to the Pustertal and here diversion of drainage appears to have taken place. The Gail trench comprises two contrasted sections, the upper Gail valley or Lesachtal as far as Mauthen, and the lower valley from Mauthen to the Drau confluence below Villach. The upper valley has a steep gradient and is frequently a ravine below rock terraces. Below Mauthen, where the Gail valley ice was reinforced by ice over the Gailberg saddle, the valley broadens to a width of over a mile and its flat, ill-drained floor is diversified by large alluvial fans built up by side streams. Settlements and cultivation are concentrated on the terraces above the meandering river, but the contrast between the *Sonnenseite* and the *Schattenseite* (the *adret* and the *ubac* of the French Alps) is striking. The high insolation experienced on the south facing slope is reflected in the widespread forest clearance, the large number of farms and barns scattered over the slope, the importance of the hay crop, and the concentration of hamlets and villages on the fans and terraces above the meadows of the Gail flood plain, with its winter temperature inversions. The north-facing slope, on the other hand, remains mainly forested, the pines and birches contrasting with the woods of sweet chestnut across the valley. A warm, dry, local wind of the föhn type is experienced here and known as the *jauk*. The number of Slovene place-names, such as Hermagor and Dobratsch, point to the early penetration of this valley from south-eastern Europe, as well as by German settlers, as at St. Jakob and St. Lorenzen.

In contrast with the almost rectilinear W.N.W.-E.S.E. course of the Gail, the Drau has a devious and composite course. The river has two headstreams, the Isel, which flows south-eastwards from the Gloss Glockner, and the upper Drau, which drains the Pustertal in East Tirol. These streams meet at Lienz (Fig. 3) but the combined stream continues the south-eastward direction of the upper Isel in a trough powerfully overdeepened by the Isel valley glacier from the Gross Glockner region. A little to the east of Lienz, however, a col, known as the Iselsberg, appears to have been overridden by ice diverging from the combined ice-stream into the central Möll valley. This saddle is utilised by a road which ascends from the Drau trough to the divide at 5,724 ft. by a series of hairpin bends (Plate III); this road is a section of the Gross Glockner tourist route from Klagenfurt and Villach. To the east of it the Drau enters Carinthia by the " Tirolean Gate " and flows in a broad, ill-drained trench between the crystalline rocks of the Kreuzeck Group and the limestones of the Gailtaler Alps. At first, its direction corresponds with

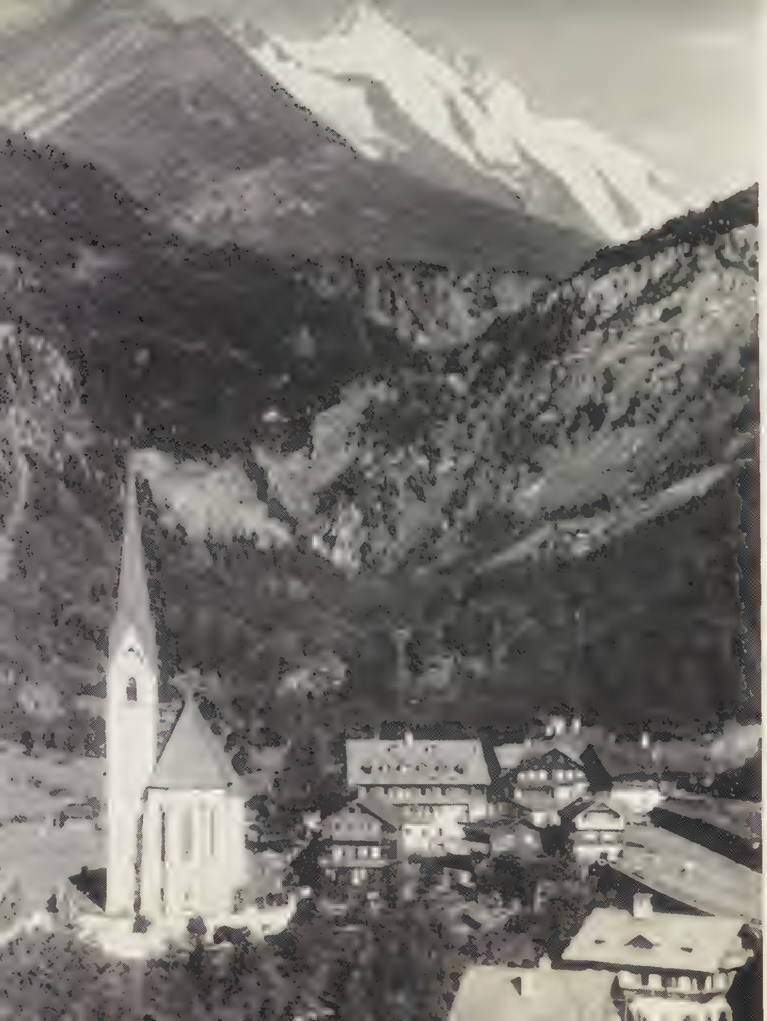


Plate I. The Gross Glockner from the high altitude resort of Heiligenblut, a village which suffered much damage and loss from avalanches during the winter of 1951-2. (Klagenfurt Travel Bureau).

Plate II. The lake side resort of Pörtschach am Wörthersee. The wooded peninsula and islands are partially submerged parts of a terminal moraine. (Klagenfurt Travel Bureau).

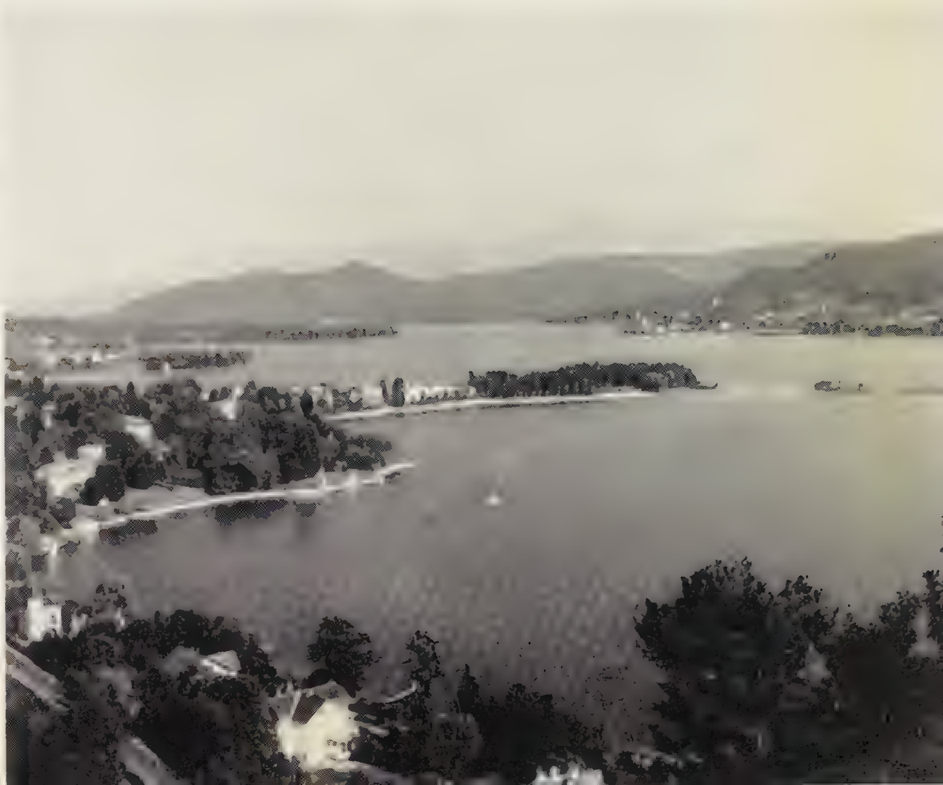


Plate III.—The trench of the upper Drau below Lienz, looking south-westwards from th
Iselsberg road towards the Lienzer Dolomites. (Author's photograph).

Plate IV.—The Karawanken Range from Velden at the head of the Wörthersee. Between th
distant peaks and the forested ridge of the Sattnitz lies the depression of the Drau valley know
as the Rosental. (Klagenfurt Travel Bureau).

the ice tongue which advanced down the Drau valley and over the Kreuzberg col to the Weissen See, but the Drau turns away to the northeast across the crystalline rocks to swing through a sweeping incised " elbow " at Sachsenburg and be joined by the Möll from the northwest. As at Lienz the Drau takes up the direction of its tributary and turns south-eastwards to Villach. At Spittal, the Drau is joined by the Lieser, the small town being built on the great detrital fans laid down by this alpine torrent between the finger lake of Millstatt and the flat-floored, alluviated trench of the Drau 200 ft. below. Between Villach and Klagenfurt, the Drau appears to have abandoned its direct pre-glacial course across the Klagenfurt basin[6], preserved in part by the Wörther See and its eastward outlet. It swings away to the southern rim of the basin and, in its meandering course through the Rosental south of the Sattnitz upland, continues the alignment of the Gail (Plate IV). Finally it turns once more to the north-east, to be joined by the Gurk 10 miles east of Klagenfurt, and enters the Jauntal, a wide stretch of lowland between the Karawanken Range and the Sau Alps. The Lavant joins the Drau at Lavamünd and the Austrian section of the valley ends where the Drau enters Yugoslavia through the gorge already described.

## THE HISTORY OF SETTLEMENT

The province of Carinthia owes its historical importance to its rôle as a passage land between northern Italy, Istria and the Dalmatian coastlands on the one hand, and Styria, Vienna and the Middle Danubian lands on the other. Connection north-eastwards with the Tirol and Bavaria was very difficult until the development of modern routes through the Hohe Tauern barrier. However, long distance trade between the Baltic coastlands and the Mediterranean has passed through Carinthia from pre-historic times, amber being the first commodity known to have been carried. The iron ore deposits of Styria were known to the Celts of the late Iron Age and led to Roman trade with the province of Noricum. In recent years new excavations have brought to light fresh evidence of the importance of Roman settlement in Carinthia and of the road system. The Roman capital of Noricum was *Virunum*, a town in the depression north of Klagenfurt known as the Zollfeld. Through this town passed the roads from Aquileia, over the Plöcken pass and by the Pontebba-Tarvisio route, leading to the iron mines in the Mur valley and so by the Semmering to Vienna (*Carnuntum*). A Roman road crossed the Drau near Villach at *Santicum*, the site of a Roman spa, now Warmbad-Villach. Roman tablets have recently been found on the Plöcken pass and are exhibited in the museum at Klagenfurt. At Maria Saal, north of Klagenfurt, there is a cathedral in romanesque style and the Roman bas reliefs incorporated in the building are well known. Excavations on the nearby Magdalensberg since the war suggest that this site, rather than *Virunum*, was their place of origin. Here stood a Celto-Roman town, 3,000 ft. above sea level, of considerable magnitude. The Roman rooms in the museum at Klagenfurt exhibit a wealth of finds from the site, including a tesselated pavement with Bacchus as the central figure, comparable in splendour of workmanship with those of *Verulamium*. A second site is also now being excavated. It lies in the Drau valley, northwest of Spittal, at St. Peter-im-Holz. It is known as *Teurnia*. About 35 miles farther up the Drau valley, near Lienz, lay the Celto-Roman town of *Aguntum*.

---

[6] N. Krebs. *Die Ostalpen u. das Heutige Osterreich*, vol. I, map on p. 85.

The medieval period saw the gradual clearance of the forested valleys, especially on the south-facing slopes, during the *Rodungszeit*, and the advance of both Slavonic settlement up the Drau valley from the southeast and of Germanic settlement from the Alpine valleys to the north. It would appear that, whereas the typical Slovene settlement was the hamlet or dispersed farmstead (a feature still characteristic of the Rosental and Jauntal regions) the German colonisers founded agglomerated villages and small towns, the latter frequently occupying defensive sites. The rich soils of the Klagenfurt lake basin, developed from lake silts and loess, and those of the Rosental to the south, favoured crop farming on the strip system. On the other hand, the steep slopes and poor soils of the Alpine valleys sustained only a pastoral economy, based on hay as winter feed and involving the seasonal migration of sheep and cattle to the mountain pastures above the tree line. Transhumance is still generally practised, even by the prosperous farmers owning large mixed farms in the Klagenfurt basin, some owning grazing rights on the *almen* as far away as the Möll valley, on the southern slopes of the Hohe Tauern.

The most prosperous farming regions to-day, as for centuries past, are the lake basins and the river lowlands of the lower Drau, i.e., the Rosental, and the Lavant valley, known locally as the "Paradise of Carinthia." In this latter region, shelter and sunny aspect, combined with well-drained slopes and the stimulus of the medieval monastic houses, have long favoured the cultivation of the vine, between Wolfsberg and St. Paul and on the foothills and terraces of the Kor Alps. To-day, metallurgical and wood working industries have been added to the resources of the valley and are based on local iron ore and lignite and hydro-electric power developed at St. Stephan. In southern Carinthia, the wide agricultural lowland, with its drift soils, extending from the rolling foothills of the Karawanken Range to the Sattnitz upland, produces a wide range of crops. Here the growing season is long enough and the summer rainfall adequate for maize, wheat, lucerne and tobacco, crops which are grown under rotation in open strips. Much of the land is under either sown or natural meadow land, yielding, under the scythe, an abundant hay crop. This is dried on open racks, protected from the rain by shingle roofs, in typical Slovene style, and dotted about the fields. Fruit trees are widespread in the meadowland and also along the roadside, the walnut, cherry and apple being most frequently found. This rich and intensively farmed lowland is cultivated very largely by Slovene peasants, on traditional lines, with much hand labour. The Germanic farmers are more usually concerned with stock farming and their economy is that of the Alpine peasant of Central Europe. A Yugoslav writer has suggested that since the war the most overpopulated districts of Carinthia are in the southern Slovene region, a feature also found across the frontier in Carniola. Here the number of rural inhabitants often exceeds 425 per square mile of arable land, a very high figure by west European standards[7]. Increasing industrialisation may offer a partial solution of this problem.

Carinthia is poor in mineral resources compared with Styria, with its rich iron mines and lignite. The existence of precious metals encouraged small scale settlement by German miners in the 16th century, especially in the upper Möll valley, but these gold and silver deposits have long since been exhausted, though the lead and zinc mines of the Bleibergtal in the Erzberg are still working.

Many of the small urban settlements of Carinthia appear to have evolved around an ecclesiastical or feudal castle nucleus. Some of the romanesque cathedral foundations, such as those at Gurk and at Maria Saal in the Zollfeld district, dating from the 15th century, have not given rise to settlements of any size or importance. The Benedictine monastic houses at Millstatt and at St. Paul, in the Lavant valley, are architecturally interesting. So are the two churches of Maria Wörth. This village has a beautiful site overlooking the lake of Wörth and backed by the wooded slopes of the Sattnitz, with the pyramidal peak of the Mittagskogel, in the Karawanken Range, rising to 8,991 ft. in the background. The romanesque Rosenkranz church has as reminders of the Slovene element in the local population, a tombstone in Cyrillic script in the churchyard and a porchway with a thatched roof. In extreme contrast with this lake side village is the high altitude resort of Heiligenblut, a cluster of farm buildings and modern hotels in châlet style at 3,903 ft. in the upper Möll valley. The place name is associated with St. Briccius who died here on his return from Constantinople, bearing with him a flask said to contain the Sacred Blood. The church stands on the site of the saint's burial place and dates from the 15th century.

The frontier character and chequered history of the province are reflected in the wealth of fortified and walled towns, and of medieval castles on defensible bluff sites. The important routeway leading northwards from Klagenfurt to Styria and the Mur valley provides some splendid examples. Friesach, with its medieval walls and moat, is known as the Rothenburg of Carinthia, and St. Veit, north of Klagenfurt, owed its past importance to the fact that it was the seat of the Dukes of Carinthia. East of St. Veit on craggy sites are the fantastic castles of Hochosterwitz and Frauenstein. By comparison with these early and picturesque settlements, the two chief towns of modern Carinthia, Klagenfurt and Villach, appear to offer less of interest, though Klagenfurt has its medieval nucleus.

---

[7] Sevtozar Ilešič, "La densité de la population en Carinthie." (French summary), *Geografski Vestnik*, vol. XVIII, Ljubljana, 1946.

### KLAGENFURT

With a population of 65,800 in 1951, Klagenfurt is the provincial capital of Carinthia and currently the headquarters of the British Army of Occupation. Like Villach, it is an important route centre and railway focus (Fig. 1), and, in consequence, both towns were heavily bombed during the later phases of the war. Klagenfurt lies at 1,388 ft., the town replacing an earlier settlement, known as Glanfurt, i.e., a fording place over the Glan, which was founded in 1193. The present town dates from 1240, when the city was founded by Duke Bernhard of Sponheim. The Glan originally flowed through the centre of the town but was afterwards diverted to the north. In 1518, Klagenfurt replaced St. Veit as the capital of Carinthia, the Diet meeting in the Landhaus, an impressive building in Renaissance style, with an arcaded courtyard. Nearby is the cathedral, overlooking the old market place, known as the Alter Platz (Fig. 2). Here may be found the medieval street names, such as Herrengasse (the street of the knights), Kramergasse (the street of the tradesmen), and the Obst Platz (fruit market). The newer town has been laid out in blocks around the Neuer Platz, with its dragon fountain (the symbol of the town, with its association with the Order of St. George). The limits of the walled town may be traced in the broad thoroughfares which, as in Vienna, form an inner " ring." They are named after the Carinthian towns to which the gates in the walls gave access: St. Veit, Villach, Viktring and Völkermarkt. The modern part of the town extends around this central block, within the outer " ring " or *Gürtel*. To the south of the town, the heavily bombed railway station is being rebuilt and there is much new housing under construction nearby. Northwest and north of the town lies the " green belt," inside the " ring," consisting of the Schiller, Goethe, Schubert and Rauscher parks. A strip of open country lies between the town and the Wörther See to the west, with which it is connected by the Lend canal.

### CONCLUSION

Carinthia, essentially an Alpine province, with its snow-capped peaks in the northwest and its forests and lake scenery in the southeast, offers a variety of interest to the geographer. The Alps provide a source of wealth in their scenic beauty, their softwood timber, mountain pastures and water power, but it is in the lowlands that the highest densities of population occur, notably in the Villach-Klagenfurt basin. Here, in contrast with the pastoral economy of the Alpine valleys, based mainly on summer grazing and the hay crop, is a region of rich arable and mixed farming, interspersed with wooded slopes. Southern Carinthia is pre-eminently a region of Slovene peasant life and economy, but, elsewhere, the province has become almost entirely Germanized, as the result of long centuries of penetration from Central Europe. In modern times, Carinthia has became more accessible from Western Europe, through the opening of the Hohe Tauern railway in 1909, and the completion of the Gross Glockner road some 30 years later, thus bringing new life and contacts to hitherto remote Alpine valleys and lake and river lowlands.

CARINTHIA, 1951

| | |
|---|---|
| Area | 4,583 square miles. |
| Population | 482,886 (96 per cent. German speaking ; 4 per cent. Slovene). |
| Land use | 16 per cent. arable.<br>34 per cent. meadow and hill grazing.<br>48 per cent. forest and woodland. |

◆

# THE HYDRO-ELECTRIC POWER SCHEME IN THE GLOCKNER-KAPRUN AREA OF AUSTRIA

ROGER COLE*

IN spite of her small size Austria exemplifies some important aspects of the increasing use being made of hydro-electric power in many parts of Europe.

Pierre George[1] indicates a division of Europe into three zones in relation to power. On the basis of these Table I (p. 100) indicates some recent tendencies.

The sub-division[2] of the southern zone of European mountains shows clearly that the sections in Spain to the west and in the Carpathian area to the east are less developed than the central Alpine region. Austria, although a junior member, is undoubtedly one of the group of countries within this central region which is suitable for even more intensive development of hydro-electric power before capital resources are applied to the other sections.

In 1947 4,000,000,000 kWh. out of a total Austrian production of 4,800,000,000 kWh. was supplied by water power. The Glockner-Kaprun hydro-electric scheme will be a substantial addition to this when it is in full operation. The project was described briefly by Dr. Alice Mutton in the *Geographical Review* in 1951[3], but appears to be less well known in this country than other much larger, but generally less advanced, schemes in the western Alps.

---

* Mr. Cole is geography master at the City Grammar School, Sheffield.

[1] P. George, *Géographie de l'Energie, Géographie Economique et Sociale*, vol. IV, Paris, 1950, p. 278.

[2] P. George, *op. cit.*, p. 301.

[3] Alice F. A. Mutton, "The Glockner-Kaprun Hydro-electric Project, Hohe Tauern, Austria," *Geogr. Rev.*, vol. 41, 1951, pp. 332–334.

Most countries in the Alpine area are carrying out schemes for expansion of hydro-electric power production[4]. This is in striking contrast to the type of new plant being built in Britain[5]. Some of the Alpine schemes involve co-operation between two or more countries. e.g. The *Emalp* Scheme (Western Alps) including the Val d'Isère project. In addition to national programmes there also exists a supplementary " International Programme " under oversight of the Committee of European Economic Co-operation. This aims at bringing capacity in the participating countries up to requirements more quickly than could be achieved by the national programmes alone. Of the nine projects involved six rely upon hydro-electric power. Among the factors taken into account by O.E.E.C. were that " some countries relying partly on high altitude hydro-electric power have sufficient gross production over a calendar year, but an insufficient proportion of this production during the winter " and " some countries (e.g. Austria) have a surplus of power in one part of their territory and a deficiency in another "[6]. Although not part of this O.E.E.C. programme the Glockner-Kaprun scheme indicates how steps may be taken to overcome these particular difficulties.

Austria may be broadly divided into three power zones :

(1) East of the Linz meridian where most of the thermal power stations lie. This region, of course, includes the main industrial and population areas near Vienna[7].

(2) The Alps as far west as Upper Pinzgau. Hydro-electric power is considerable. The power is supplied to many places in the Salzburg-Linz area, but transmission to Vienna is important and the Glockner-Kaprun scheme is largely intended to increase this.

(3) The Tyrol-Vorarlberg area in the extreme west of Austria. Hydro-electric power development is intensive. Besides supplying the needs of Innsbruck, the railways and small towns there is a link to the South German grid. Future development is planned to increase the export of power from this area.

A major drawback of many hydro-electric power schemes relying on glacier-fed rivers is that it is not easy to arrange for peak output to coincide with the peak demand which is normally in winter. For example in France where hydro-electricity supplies almost exactly 50% of total requirements it dominates summer output, but is exceeded by thermal power in winter. George[8] shows that, for a twenty-four hour period, hydro-electric power in winter accounts for little more

---

[4] Alice F. A. Mutton, " Hydro-electric Power in Western Europe," *Geogr. Journal*, vol. CXVII, pp. 328–342.

[5] E. M. Rawstron, " The Distribution and Location of Steam-driven Power Stations in Great Britain," *Geography*, vol. XXXVI, 1951, pp. 249–262.

[6] Committee of European Economic Co-operation. July–Sept., 1947. *Technical Reports*, vol. 2, p. 131.

[7] Filip Hjulström, " The Economic Geography of Electricity," *Geographica : Skrifter från Upsala Universitets Geografiska Institution*, No. 12, Uppsala, 1942, p. 142.

[8] P. George, *op. cit.*, p. 236, Fig. 20.

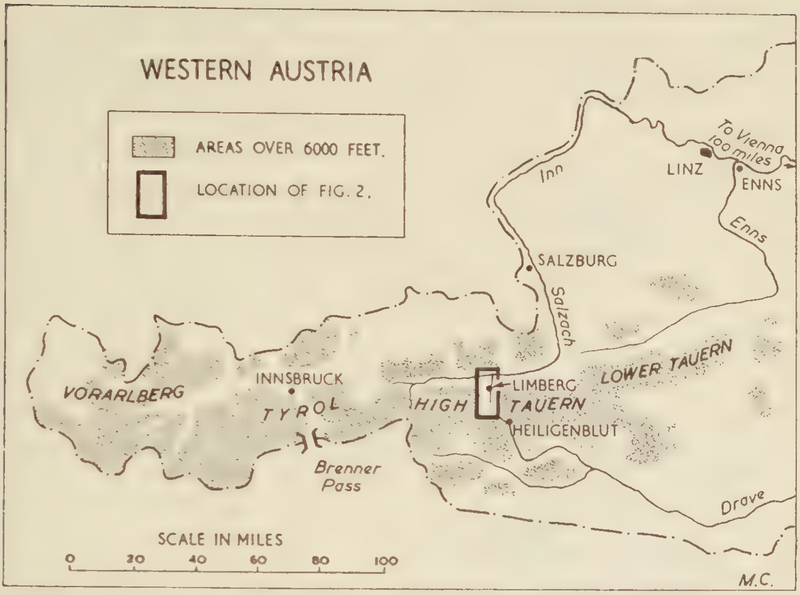


Fig. 1.

than half the total from steam power stations. The greater the reliance on water power the greater the difficulty of meeting winter demand. The Glockner-Kaprun scheme is intended to overcome this difficulty to a considerable extent.

Even within the relatively small area of Austria there are marked differences within the Alpine zone. As we should expect, the eastern areas are lower, experience a smaller total precipitation and thus have a smaller hydro-electric power potential. Further, towards the eastern part of the Austrian Alps there is a change in the river regime from a predominantly glacial regime (maximum flow July–August) to one in which the late spring snow-melt is important, e.g. River Enns (see Fig. 4B). The northern tributaries of the Danube have a summer minimum and a spring maximum. This variety of regime may be a definite advantage in integration of power schemes within Austria, but the problem of turning to account the very high summer flow from the Hohe Tauern remains.

In the Alps as a whole there is a striking contrast between the utilisable gross head in different valleys. That in longitudinal valleys is 2–5 metres per kilometre. In transverse valleys it is often 100 metres per kilometre rising to 400 in favoured areas[9]. The Glockner-Kaprun scheme is in a transverse hanging valley (see Fig. 1) and the head is relatively high. Although not international in the same way as the *Emalp* scheme referred to above it does involve precisely the same principle—namely transfer of water from a glacial supply by high level pipelines from one catchment area to another. In fact the water is transferred through the main Alpine water parting. The high summer flow is to be stored to produce power to meet winter needs, and this power is to be transmitted from the mountain area to meet general industrial and domestic needs in the lowland part of the country.

---

[9] Hjulström, *op. cit.*, p. 141.

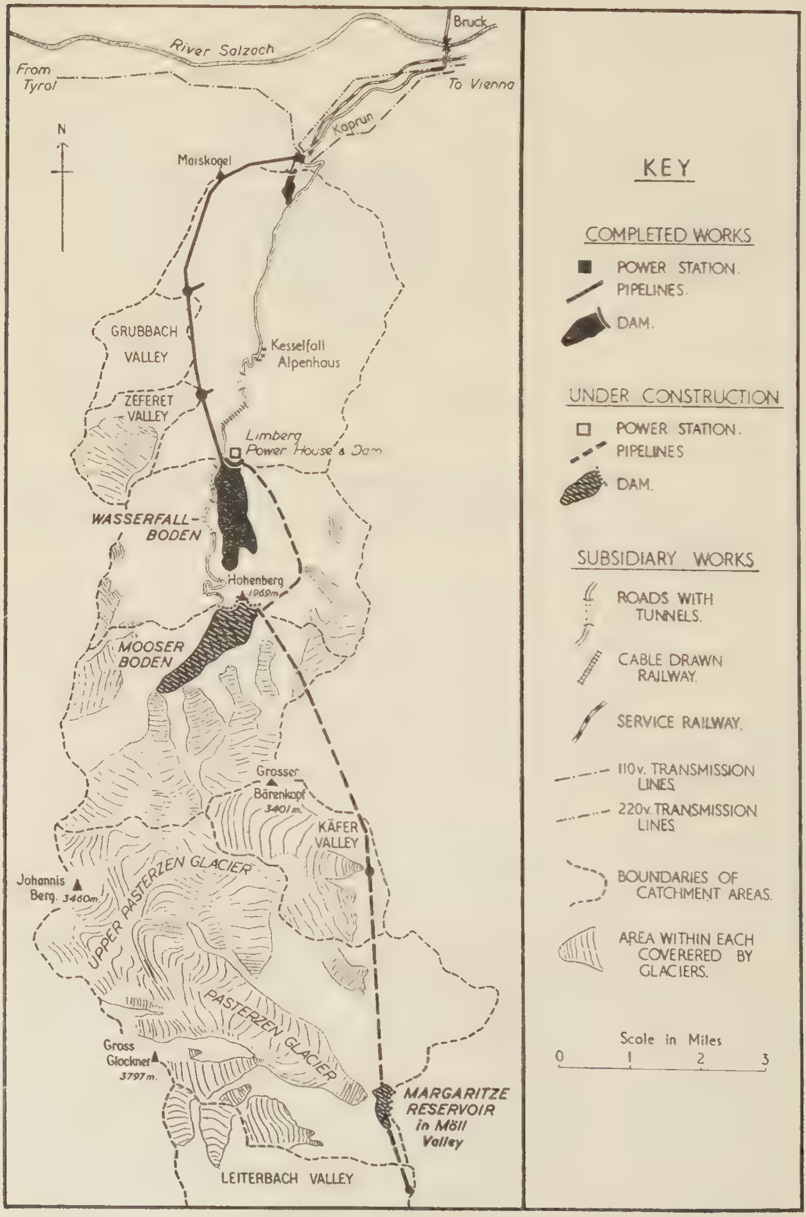


Fig. 2.—Glockner-Kaprun Power Scheme, 1952.

The main part of the construction for the scheme[10] is in the transverse valley of the northward flowing Kapruner Ache. This stream meets the Salzach in its west–east longitudinal valley at Bruck a few miles from Zell am See. The situation is particularly favourable. Relatively short pipelines are required to carry the water, there is a high fall and two suitable sites for dams—one at Mooserboden and one at Wasserfallboden (see Figs. 2 and 3). To increase the value of the undertaking the flow of water from the Pasterzen glacier to the River Möll, a tributary of the Drave, will be held in a supply reservoir at Margaritze and carried to the Mooserboden reservoir. This supply reservoir lies south of the main Tauern ridge at the foot of the Gross Glockner which gives its name to the scheme.[11]

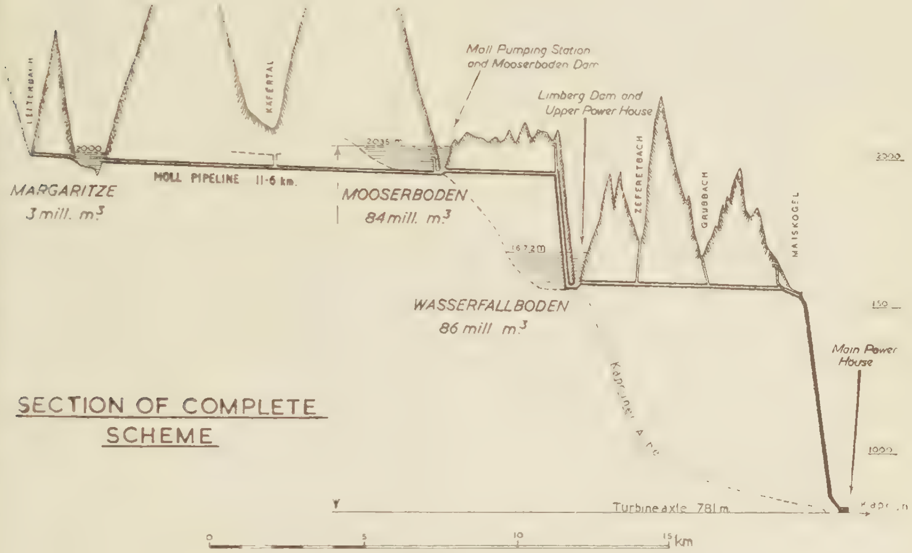


Fig. 3.

The type of power undertaking being built is known as a "Speicherwerke" (storage scheme) because a comparatively large quantity of water is stored up in summer so that it may do work in winter at the time of greatest need for electrical energy. The water from the Mooserboden reservoir will first go, via the power house, to the Wasserfallboden reservoir and from there to the lower end of the valley. There will also be a means of pumping water up out of the Wasserfallboden reservoir into Mooserboden at times of surplus power so that it may be used again at times of greater demand.

The combined use of available physical and constructional resources will give the two reservoirs a capacity of about 170,000,000 cubic metres of water. It is because the total annual precipitation within the natural catchment basins of these reservoirs is less than this figure that the water from the Margaritze supply reservoir will be so valuable.

---

[10] The text and maps describing the scheme are largely based upon J. Götz, *Das Tauernkraftwerk Glockner-Kaprun*. Zell am See, 1951.

[11] The situation is described by Dr. Mutton in her article on Carinthia in this issue on p. 86.

CATCHMENT AREAS

| | % Glaciers | Precip'n. m.m. | Area km² | Run-off. Million m³ | | |
|---|---|---|---|---|---|---|
| | | | | Summer | Winter | Annual |
| Grubbach .. | 0·0 | 1,750 | 4·5 | 6·3 | 1·0 | 7·3 |
| Zeferet .. | 54·0 | 2,300 | 4·4 | 8·3 | 1·1 | 9·4 |
| Wasserfall .. | 34·6 | 2,250 | 19·8 | 82·3 | 11·3 | 93·6 |
| Mooserboden | 54·0 | 2,590 | 21·8 | | | |
| Käfer .. .. | 61·0 | 2,520 | 9·6 | 20·2 | 2·7 | 22·9 |
| Möll .. .. | 60·0 | 2,100 | 44·4 | 99·6 | 12·8 | 112·4 |
| Leiterbach .. | 7·0 | 1,360 | 19·6 | | | |
| | | | | 216·7 | 28·9 | 245·6 |

Of the available water in summer 167·6 million cubic metres will be stored in the two main reservoirs and added to the supply in winter when 75% of the total power will be produced.

The Wasserfallboden reservoir and the power house in Kaprun constitute the main stage of the scheme. Work on the concrete of the Limberg dam—the retaining wall for Wasserfallboden—began in the autumn of 1948. It was completed in three years and opened in September 1951. Pipelines to carry the water along the western side of the valley to the penstocks at Maiskogel are completed. Water from the Zeferet and the Grubbach valleys enters the pipeline on the way. Two out of four of the high pressure pipes which will carry the water down to the powerhouse at the foot of the Maiskogel near the village of Kaprun are at present in use. Two turbo-generator sets give an output of 90,000 kW. ; two further sets will ultimately raise the capacity of this power house to 200,000 kW. Current is led directly to the switch gear in the open. From there 110,000 volt and 220,000 volt transmission lines will carry current direct to Vienna.

In connection with the work a service railway, workshops, camps and stores have been built near Kaprun. The access road to the site also starts from here. When a party from the City Grammar School, Sheffield, visited the valley in 1951 it was possible to go by bus along this road to the foot of the main glacial step in the valley at Kesselfall Alpenhaus. The step is traversed by a cable-drawn railway which is used for supplies only since the number of visitors wishing to use it in order to avoid a rocky winding path proved too great and work was interrupted. From the top of the railway an upper road leads past the crest of the Limberg dam. This road was followed along the side of Wasserfallboden. It is built near the water level but nevertheless includes several quite long tunnels in solid rock. It rises beyond the reservoir towards Mooserboden where the party reached a height of 2,100 metres. Cement from the railhead at Kaprun and gravel from sites in the valley were then being taken to building sites by overhead

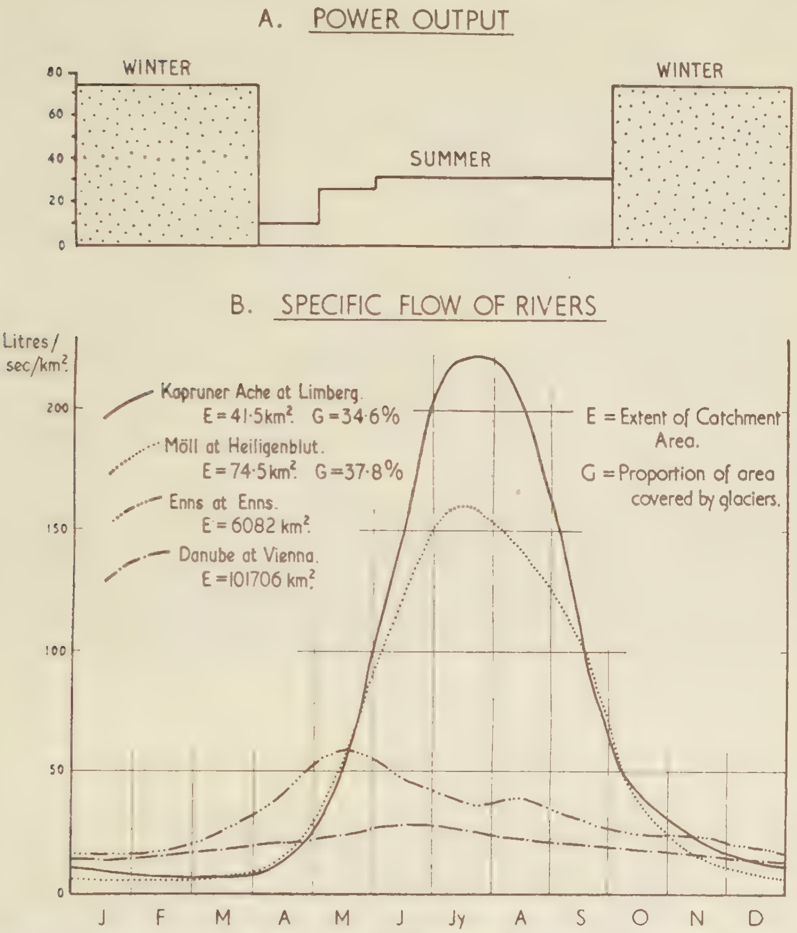


Fig. 4.—In Fig. 4a the scale represents millions kWh. It indicates a total annual production of 600 million kWh., which excludes additional output from use of pumping facilities.

cable railways. Special plants have been erected to prepare the glacial gravels available in the valley.

Foundations were being made at Mooserboden on which dam walls will be built to block the valley on both east and west sides of the Höhenberg. The Möll transfer pipeline, 11·6 km. long, was being constructed from either end and also from an intermediate point.

When the whole scheme is complete production will rise from just over 200,000,000 kWh. to about 800,000,000 kWh. This will be obtained from generators with a total output of 312,000 kW. and will be available largely during the winter months (see Fig. 4A). The scheme will thus have a very significant place in the supply of energy in Austria.

It is this type of power scheme which is likely to add greatly to the power output of western Europe during the next few decades.

The power from these transverse Alpine valleys will to an increasing extent be used in the piedmont regions of Europe. In some cases it will go not only to population areas such as Vienna but, perhaps, even to areas whose development has depended in the past directly upon great coalfields. Recent discussion of the possibility of linking French Alpine power to the British grid is a case in point.

TABLE I.—ELECTRIC POWER PRODUCTION (millard kWh)

| | 1937<br>H.E.P. | Thermal | Total | 1947<br>H.E.P. | Thermal | Total | % H.B.P. |
|---|---|---|---|---|---|---|---|
| *Northern Zone* | | | | | | | |
| Norway .. .. | 9·2 | 0·1 | 9·3 | 11·8 | — | 11·8 | 100·00 |
| Finland .. .. | 2·8 | — | 2·8 | 2·7 | — | 2·7 | 100·00 |
| Sweden .. .. | 7·3 | 0·7 | 8·0 | 14·0 | 1·0 | 15·0 | 93·33 |
| *Central Industrial Zone* | | | | | | | |
| Belgium .. .. | — | 5·5 | 5·5 | — | 6·0 | 6·0 | 0·00 |
| Great Britain .. | 1·0 | 22·0 | 23·0 | 1·5 | 40·5 | 42·0 | 3·57 |
| Germany.. .. | 6·5 | 42·4 | 48·9 | 7·2 | 29·0 | 36·2 | 13·29(1937) |
| Czechoslovakia | 0·5 | 3·5 | 4·0 | 1·0 | 5·3 | 6·3 | 15·87 |
| U.S.S.R.(whole) | 10·0 | 30·0 | 40·0 | 18·0 | 60·0 | 78·0 (1946) | 23·08 |
| France .. .. | 10·1 | 10·0 | 20·1 | 13·0 | 13·0 | 26·0 | 50·00 |
| *Southern Zone* | | | | | | | |
| (a) *Western* | | | | | | | |
| Spain .. .. | 3·2 | 0·1 | 3·3 | 3·0 | 1·0 | 4·0 | 75·00 |
| (b) *Central* | | | | | | | |
| Italy .. .. | 15·0 | 0·2 | 15·2 | 20·0 | 0·8 | 20·8 | 96·01 |
| Switzerland .. | 6·8 | — | 6·8 | 10·0 | 0·1 | 10·1 | 99·01 |
| Austria .. .. | 2·5 | 0·6 | 3·1 | 4·0 | 0·8 | 4·8 | 83·33 |
| (c) *Eastern* | | | | | | | |
| Yugoslavia .. | 0·6 | 0·3 | 0·9 | 1·0 | 0·5 | 1·5 | 66·66 |
| Bulgaria .. .. | 0·1 | 0·1 | 0·2 | 0·2 | 0·2 | 0·4 | 50·00 |

Statistics based upon P. George, *op. cit.*, p. 276.

# CHILDREN'S REACTIONS TO GEOGRAPHICAL PICTURES

MOLLY LONG*

THIS experiment was devised and carried out by members of the Training College Section of the Geographical Association at the instigation of their research committee. After preliminary experiments, it was decided to use the technique of interview with three pictures (Plates I, II and III) as a basis for discussion. These pictures were selected from over 100 photographs carefully examined. They were considered to be normal landscapes, one partially man-made; they were free from signs of human geography as far as possible. Large, clear copies of these photographs were placed together in front of the children selected for interview, with the remark " What do

---

* Mrs. Long is Lecturer in Geography at the Institute of Education, University of London. She wishes to thank sincerely, on behalf of the Research Committee, all members of the Training College Section, their students, and the staff and children whose co-operation in school made this experiment possible.

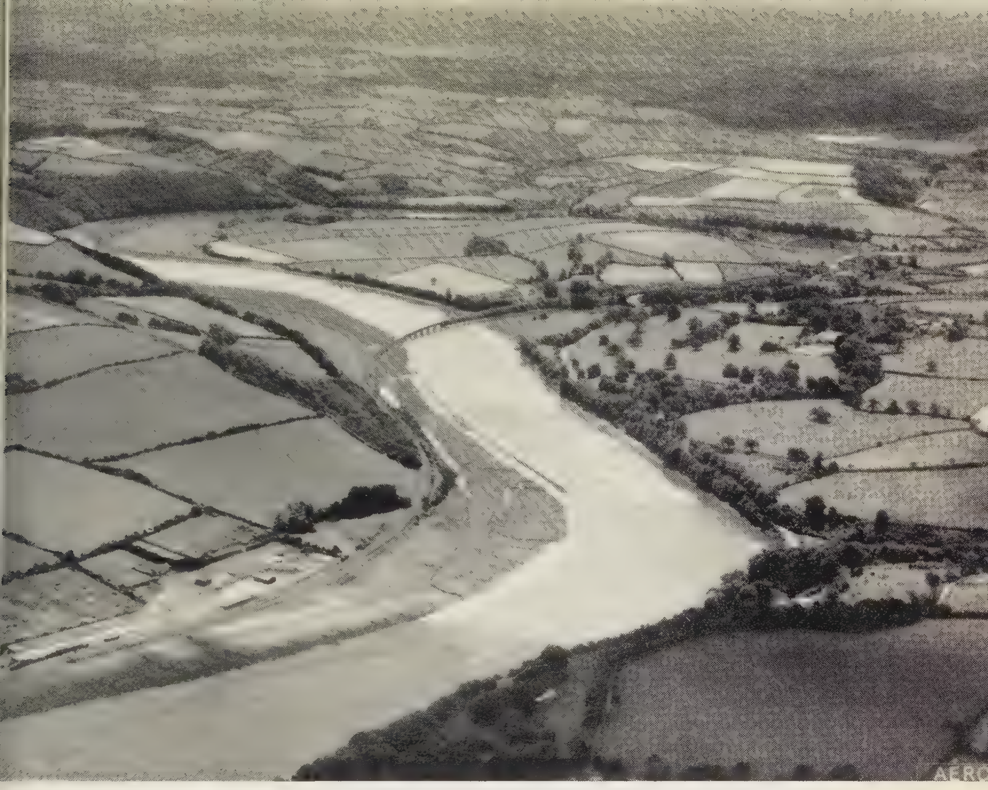
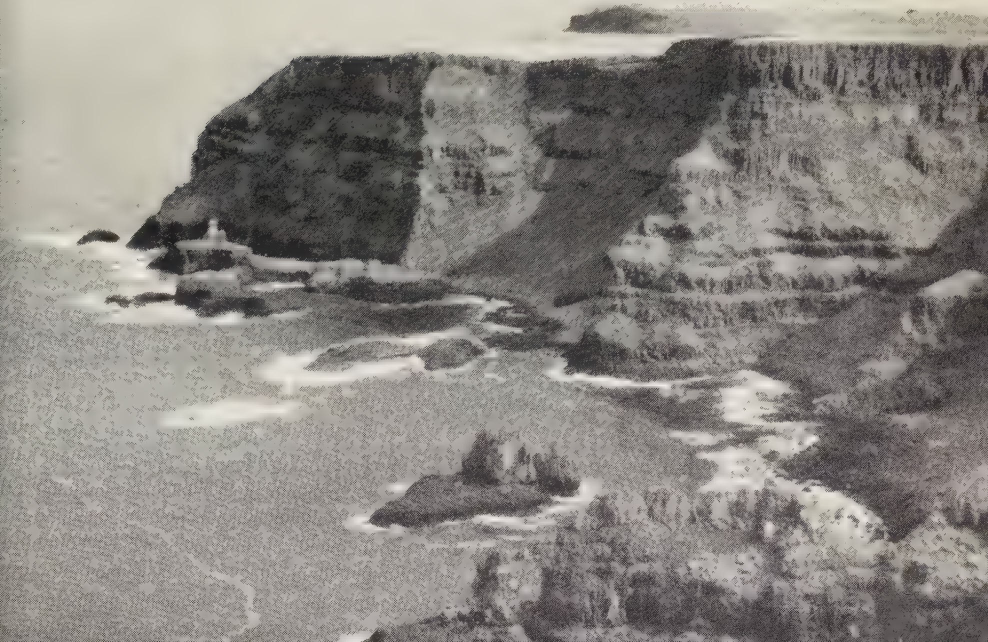


Plate I.—Bideford Area, Devon.

Plate II.—Giant's Causeway.



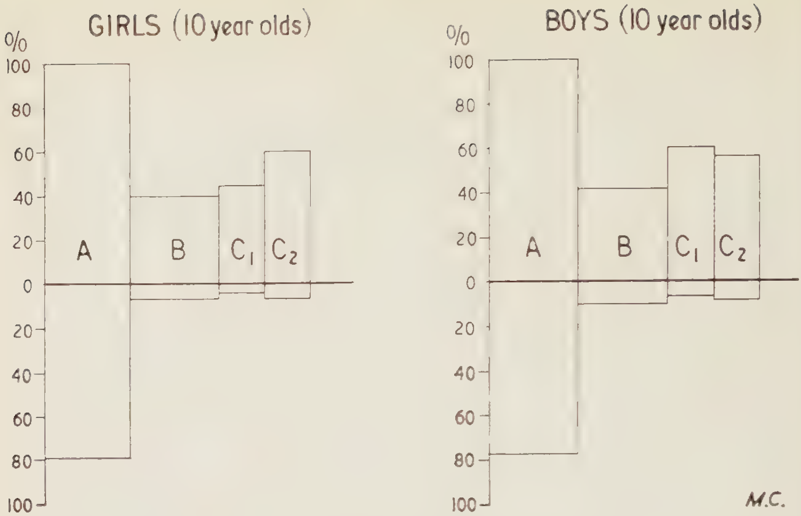
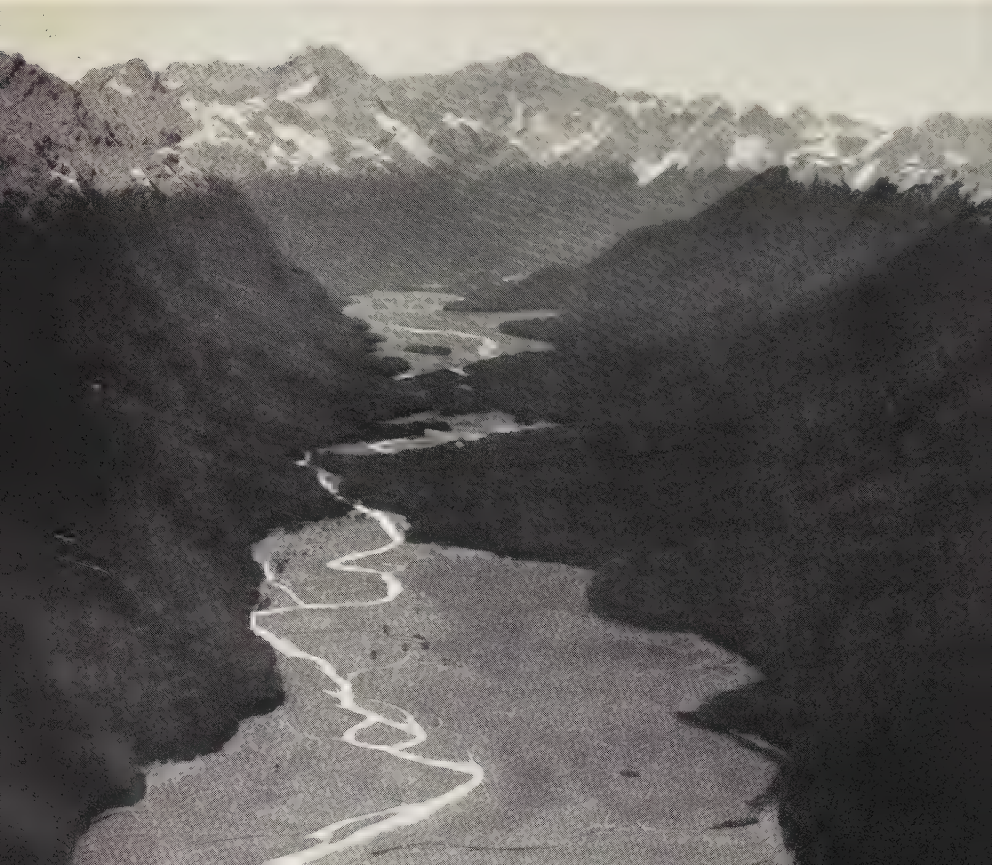


Fig. 1.—Comments expressing: A, recognition; B, interpretation; C, emotion (1, pleasure; 2, fear).

Plate III.—Eglinton Valley, New Zealand. (White's Aviation, Ltd.)



you think of these ? " The interviewer was normally the Training College student attached to the school ; in some cases it was the class teacher. Remarks were recorded either by a second student in the background or, in some cases, by means of a recording tape. The interviewer contributed as little as possible to the discussion, answering questions only as and when they arose. The recorded discussions were finally analysed and interpreted.

Although this research was initiated primarily by interest in the age at which physical geography might best be introduced with schoolchildren, it cannot be overemphasised that it lays no claim to the solution of that problem. There is little doubt that the best way of approaching physical geography is in the field, but the organisation of a large-scale experiment in field studies has yet to be realised, although many practising teachers no doubt have ample evidence of children's ability to understand physical geography when studying actual, specific examples.

The claims of this experiment are modest and limited. Its purpose was to obtain some facts about the ability of children to understand what is shown in photographs of physical geography, and the nature and extent of their interest in the features represented. Thus there is to be no attempt here to generalise about all topics of physical geography. The landscapes selected were considered normal landscape types ; the exclusion of the exciting or abnormal such as a volcano in eruption—which might well have afforded evidence of an apparent 100 per cent. interest in physical geography—was deliberate and intended.

The children were selected from primary schools all over England ; in the first instance their age range was from 9·6–10·6 years. They were interviewed in groups of three, either all boys or all girls, selected as far as possible as being of equal ability and similar calibre, with no one child of much more dominant personality than the others. The interview technique was adopted to overcome the inability of such young children to express themselves adequately in writing. When the children's own comments on the pictures had subsided, they were asked which pictures they liked most, which least, and why. All the comments were recorded.

Interviews were held in 147 urban and 49 rural primary schools in all parts of England. The schools varied in size from a roll of under 150 to one of over 600, but the majority averaged between 300 and 400 pupils. In three of the 196 schools geography was not taught at all ; in 12 it was only incidental as it arose in projects. The remainder offered geography as a subject to 10-year-olds. Only 14 of the teachers involved were specialists, that is, had received special training in geography and methods of teaching it. In the majority of schools there were two half-hour lessons weekly ; six had as long as two hours weekly, and the schools concerned with projects had from two to five hours weekly for their completion. Furthermore, in only 10 schools was geography studied out of doors with any regularity ; two of these were rural schools. Over two-thirds did no geography of any type outdoors. Finally, in less than half the schools was picture study undertaken as a deliberate part of the geography lesson, as apart from the incidental looking at a picture as it occurs as an illustration in a class book.

From schools with this background of geographical approach the recorded interviews of 438 boys and 423 girls were studied and their analysis attempted. From this analysis various points emerge.

Firstly, some indication of how 10-year-olds look at pictures :—

(*a*) It would appear that the picture is not seen, primarily, as a whole.

(*b*) It appears to be seen as a series of apparently separate and unconnected details, selected at random, haphazard.

(*c*) These details are subject to careful inspection. If the picture is not clear in any detail much time may be spent in an attempt to establish recognition. If the feature remains unidentifiable, imagination is brought into play.

(*d*) It does not occur to many children to query height, area, or size in general.

(*e*) This lack of realisation of scale apparently causes the majority of errors in recognition.

(*f*) It would seem that, if something in a picture is either not clear or not known to a child, shape rather than size suggests itself as a solution. In other words, shape recognition is stronger than size recognition.

(*g*) It is not always apparent that the child, after inspection of detail, finally sees the picture as a whole.

Secondly, the fact emerged that emotion plays a large part in the child's interpretation of a picture. This fact is probably shown most clearly in their preference of picture, and in the reasons given for that preference. An outstanding preference was shown for the Bideford photograph. It was chosen by 82 per cent. of the girls and 60 per cent. of the boys, for reasons such as : it is pretty, nice, pleasant ; it reminds me of the holidays ; you can have good walks there ; you could see the farms ; you could play by the river ; it is like the country ; there is a lot to look at in this, it shows a lot.

The picture of the Giant's Causeway was most liked by 10 per cent. of the girls and 12 per cent. of the boys. Reasons given included : it is exciting ; you could climb here ; it is the seaside ; there might be caves there ; you could play smugglers ; reminds me of holidays.

The New Zealand photograph was preferred by 8 per cent. of the girls and by the much larger number of 28 per cent. of the boys, because : it is exciting ; you could climb here ; would like to see the mountains ; you could play in the snow ; could play Indians in the forest ; this looks different, it isn't so ordinary.

The least liked of the three pictures was, quite convincingly, that of New Zealand. It was selected by 72 per cent. of the girls and 58 per cent. of the boys. Emotion figured largely : the forest is dark and lonely ; it looks cold and lonely ; too many trees and no light ; the forest is frightening ; the mountains are frightening.

# DENT

BY

**THOMAS PICKLES, B.Sc.**

NEW EDITION

## MAP READING

With seven full-page extracts from Ordnance Survey Maps with Grid, Conventional Signs, forty-six line diagrams, and seven photographs.

*Stiff Paper Cover* **3s. 6d.**

Extracts from the 6 in. and 2½ in. Ordnance Survey Maps are given as well as from the 1 in. The exercises are similar in type to those set in external school examinations.

## INTERMEDIATE MAP READING.

Illustrated with six extracts from Ordnance Survey Maps in colour, four pages of half-tone photographs and many line drawings.

*Stiff Paper Cover* 48pp. Quarto **3s. 3d.**

**THE WORLD.** With 24 pages of Photographs and 196 Maps and Diagrams 448 pp. **7s. 6d.**

**EUROPE.** With 25 Photographs and 89 Maps. Numerous Questions and Exercises. 336 pp. **5s. 9d.**

**THE BRITISH ISLES.** With 8 pages of Photographs and 81 Maps and Diagrams, Questions and Exercises. 256 pp. **4s. 3d.**

**NORTH AMERICA.** With Central America and West Indies. 8 pages of Photographs and 74 Maps and Diagrams. Questions and Exercises. 288 pp. **4s. 6d.**

**THE SOUTHERN CONTINENTS.** In three books. Each volume copiously illustrated with Maps, Diagrams and Photographs. Questions and Exercises. 144 pp. each. **3s. 9d.** each

BOOK I. SOUTH AND CENTRAL AMERICA
BOOK II. AFRICA
BOOK III. AUSTRALIA, NEW ZEALAND, & PACIFIC ISLANDS.

**A REVISION COURSE IN GEOGRAPHY.** With Statistical Appendix. 242 pp. **3s. 8d.**

BEDFORD STREET. LONDON. W.C.2

# DENT

BY

**S. J. B. WHYBROW B.Sc.**

## NORTH AMERICA

With 60 Sketch Maps and 16 pages of photographs.

Cloth Boards. **3s. 6d.** 216 pages.

## THE BRITISH ISLES

With 66 Sketch Maps and 20 Photographs.

Cloth Boards. **4s. 3d.** 204 pages.

## GEOGRAPHY NOTE BOOKS

Limp Cover. Quarto page.

| No. | | | s. | d. |
|---|---|---|---|---|
| 1 | AUSTRALIA AND NEW ZEALAND | 48 pp. | 1 | 9 |
| 2 | GREAT BRITAIN AND IRELAND | 48 pp. | 1 | 9 |
| 3 | EUROPE | 56 pp. | 1 | 9 |
| 4 | ASIA | 48 pp. | 1 | 9 |
| 5 | AFRICA | 48 pp. | 1 | 9 |
| 6 | NORTH AND SOUTH AMERICA | 48 pp. | 1 | 9 |

## PRACTICAL MAP BOOKS

Stout paper cover. **1s. 6d.** 32 quarto pages each
EACH.

I. Great Britain and Ireland. II. Europe. III. Asia.
IV. North and South America. V. Africa. VI. Australia.
and New Zealand.

**By J. K. DALE, M.A.**

## INTRODUCING GEOGRAPHY

Stiff paper cover. **2s. 0d.** 48 pages, quarto.

A brief introduction to the general principles of world geography for the lower forms of grammar and senior forms of secondary modern schools.

BEDFORD STREET. LONDON. W.C.2

23 per cent. of the boys and 19 per cent. of the girls selected the Giant's Causeway as least appealing. The reasons given were: it is lonely, there is nothing to do there; the cliffs are dangerous; couldn't swim in the sea, too rough; would slip on those cliffs; it is a dull picture, it doesn't show much.

Only 9 per cent. of the girls and 19 per cent. of the boys rated the Bideford photograph as least interesting. The reasons offered were slightly different and far more limited in range; the majority suggested the picture was too ordinary, that mountains or cliffs were more exciting, or that they preferred the seaside to the country.

The way in which the children looked at the photographs, recognising objects, projecting themselves into the scene, identifying themselves with their surroundings, and sometimes interpreting or attempting to interpret beyond the facts shown, suggested a primary threefold analysis of their comments on the basis of recognition, interpretation and emotion. In Fig. 1 the upper columns represent the percentage of children concerned; the lower columns those of comments. Emotion has been subdivided into the major classes of pleasure and fear. Study of the graph indicates that:—

(*a*) Each child contributed a remark or remarks establishing recognition of some detail.

(*b*) Nearly 80 per cent. of the comments were concerned, directly or indirectly, with recognition.

(*c*) Whereas nearly half the girls made some comment indicating pleasure, 60 per cent. expressed some type of fear.

(*d*) The percentage of boys expressing fear is nearly as great, but more boys found enjoyment or the prospect of enjoyment in the pictures.

(*e*) Some 40 per cent. of the children made a comment or comments indicating an attempt to interpret what they saw.

(*f*) Only 7 per cent. of the girls' comments, and 9 per cent. of those of the boys, were attempts to interpret or deduce, *e.g.*, it must be cold with that snow; no one could live there, there is nothing to do; that cliff is no good for ships to land.

Since many of the comments analysed under these three headings were not solely concerned with either division, and since those concerning interpretation or deduction were of various categories, a second analysis was attempted. Fig. 2 therefore, shows a five-fold division, in lettered columns representing the percentages of comments. Thus:—

A. Some 5 per cent. of comments due to the inadequacy of the photographs, *e.g.*, are these islands? is it misty?

B. Over 10 per cent. of comments indicated ignorance on the part of the children, *e.g.*, what is this white on the water? what is this fence thing round a field?

C. These comments indicated a search for more information, a wish for more facts. On these grounds those of B might have been included. The largest proportion of comments is shown in C, *e.g.*, what sort of trees are these ? is this the river Thames ? what country is this ? The desire to name and familiarise objects was strongly indicated.

D. This section concerned comments indicating interest in how the physical features shown came to be, that is, in their cause. Only 3 per cent. of the girls' comments, and 4 per cent. of those of the boys, could be included. It is of interest to note that only two basic remarks arose : (i) did the sea make the cliff like that ? and, much less frequently, (ii) what makes the river bend ? These are fundamental questions of physical geography, of course, but they occurred to less than 5 per cent. of the children, and it cannot be presumed that the other 95 per cent. already knew the answer.

E. Both sections of E were comments showing interest in related causes. $E_1$ was concerned with the effect of one physical condition or feature on another ; $E_2$ with the effect of physical conditions or features on humans and human geography. With boys and girls alike fewer comments arose under $E_1$. They were comments such as : does the cliff make the sea rough ? is the tide over the beach ? Interest in human geography was more marked, especially with girls, *e.g.*, isn't it cold here for people ? no one could live here, nothing would grow. aren't the cliffs dangerous ? isn't there a notice anywhere to warn people ? are these fields growing turnips ? Country people love turnips.

It would seem possible to offer a few tentative conclusions in regard to the ability of the 10-year-old to comprehend what is shown in these photographs of physical geography.

(1) 10-year-old boys and girls are able to recognise and name certain features of landscape. These include : river, stream, sea ; mountain, hill ; cliff, rock ; country ; forest, woods ; together with field, house, railway and bridge.

(2) Outside these basic minimum terms common to all is an encouraging and lengthy range, including : headland, horizon, bay, landscape, estuary, beach, river mouth, harbour, scenery, mudbank, source, slope, ploughed land, crops and farmland.

(3) There would appear to be some awareness of connection between physical conditions and human life and some 10-year-old children are capable of simple deduction along these lines from photographic data.

(4) It would appear, however, that much detail of physical geography escapes the eye of the 10-year-old, either not seen, not recognised, not understood, not recorded, or not regarded as worthy of comment. *e.g.*, less than 10 per cent. of the

children commented on apparently obvious features like bends in the river.

(5) It would seem that the 10-year-old child accepts landscape, represented photographically, as it is, and evidences, in general, little natural curiosity as to the cause of its formation. This is in no way suggesting that curiosity does not exist, cannot be aroused, or might not arise under different circumstances, *e.g.*, in the field.

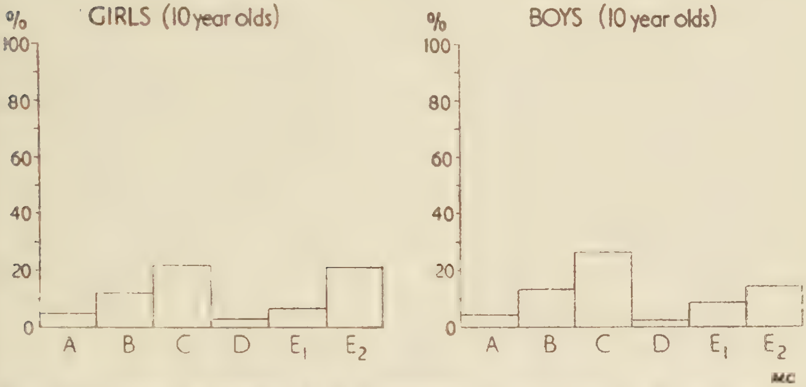


Fig. 2.—Comments expressing: A, inadequacy of photograph; B, ignorance of features shown; C, wish for more facts; D, interest in causes; E, interest in effects (1, physical; 2, human).

The natural follow-on from these conclusions was an extension of the experiment into a population of older children and this has been started with both 11- and 12-year-olds. Although, to date, numbers are far too small to offer definite conclusions, there is evidence of extended vocabulary and increased powers of deduction. An analysis of comments based on the five-fold division used previously has been included to give some indication of trends which may possibly be established on the completion of the research.

Fig. 3 is based on standard I.Q.s available for 150 boys and 150 girls from the 10-year-old group,and 50 boys and 50 girls in the 11- and 12-year-old groups. The population I.Q. curve is normal; thus a larger number of children are included in 100–115 range than in the other more extreme ranges. Only in the 10-year boys' group are I.Q.s of more than 130 recorded. It must be emphasised that numbers in the two older groups are small; this may account for some unevenness in the trends suggested.

Fig. 3 suggests, very tentatively:—

A. Inadequacy of photograph is a handicap to all ages.

B. Ignorance of facts shown apparently decreases with age and with intelligence.

C. Desire for more information is outstandingly apparent for all three age groups, but especially with 11-year-olds. It also appears to increase relatively with intelligence.

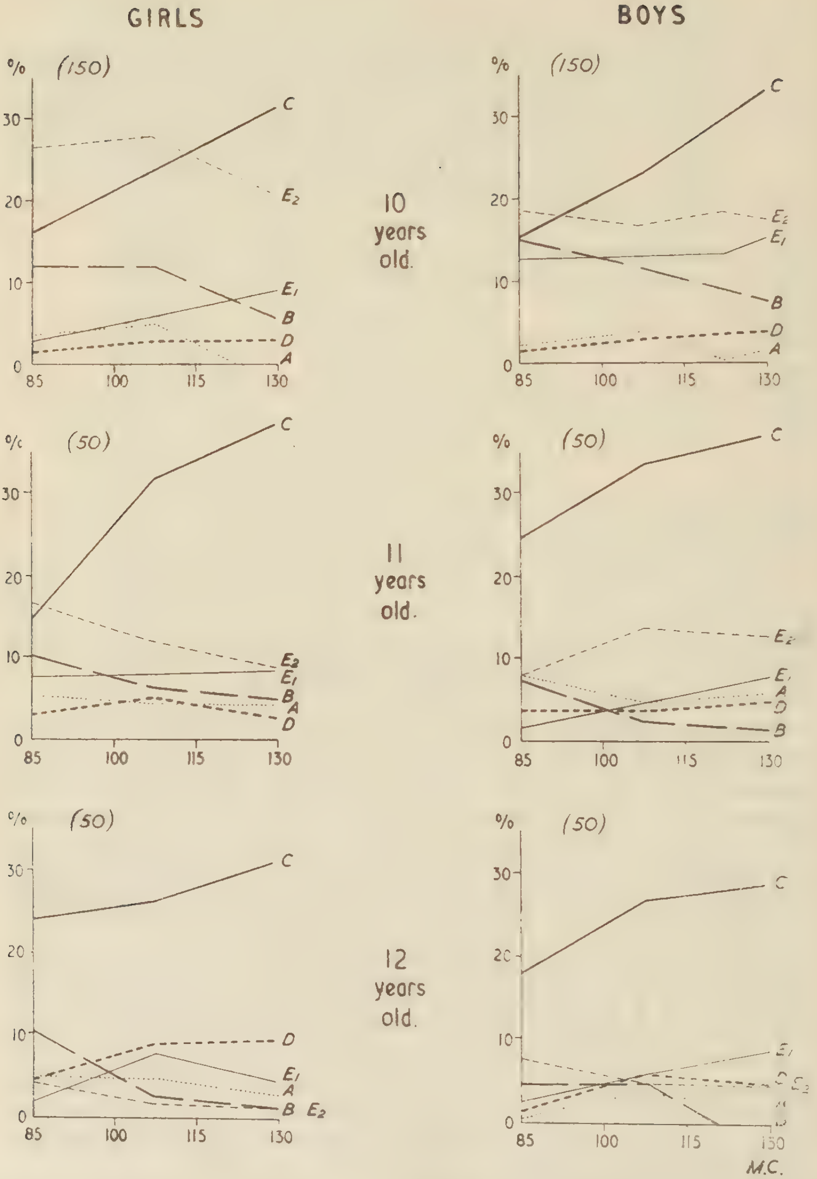


Fig. 3.—Relation of comments to Intelligence Quotients and age groups. Letters A, B, C, D, $E_1$ and $E_2$ as in Fig. 2.

D. There appears to be a slight increase of interest in the causes of physical features with age, and, in general, with intelligence.

E. There would also appear to be a slight increase of interest with intelligence in the effects of physical conditions or features on other physical conditions, at least in the case of boys. There is a marked decrease in comment concerning the effect of

# BELL

*New Edition of a Standard Book*

## THE GROUNDWORK OF MODERN GEOGRAPHY

*by* A. WILMORE, D.Sc. *Revised throughout by* E. PAYNE, M.Sc., *Lecturer in the University of Birmingham. Demy 8vo. 20s. net*

This well-known book has been completely revised and re-set throughout. While the structure of Dr. Wilmore's work has been retained some chapters have been almost entirely re-written, and additions and alterations have been made to many other chapters. All the original plates have been replaced and several new text-figures included. " Miss Payne has done first-class work in bringing this standard textbook up to date. . . . Those who have found the earlier editions useful will welcome this valuable revision."

*School Science Review.*

## THE BRITISH ISLES

*by* A. R. B. SIMPSON, M.A., B.Sc. *New edition.* 5s. 6d.

This standard book, for long regarded as a model of what a good geography textbook should be, has now been thoroughly revised and brought up to date. Reset throughout and bound in boards, the book should prove even more useful than before to General Certificate candidates.

*By the same Author :* **EUROPE** *(revised edition in preparation)* ; **AFRICA,** 4s. 6d.; **THE AMERICAS,** 7s.; **AUSTRALIA-N. Z.,** 2s.; **ASIA,** 7s. 6d.

*New Edition ready Autumn* 1953

## EXERCISES ON ORDNANCE MAPS

*by* C. H. COX, B.Sc. *and* A. J. MAGGS, B.A., B.Sc. 3s. 6d.

A new edition of this book has long been keenly awaited by schools, many of which have preserved over some years, copies of the last printing. For all practical purposes it will be a completely new book with fresh maps and photographs and questions. It will be found to satisfy fully the latest examination requirements.

*Note.*—Further limited supplies of that outstanding textbook NORTH AMERICA by J. Russell Smith and M. Ogden Phillips are now available, price 52s. 6d. net.

**G. BELL & SONS, LTD., PORTUGAL ST., W.C.2.**

SCHOOL LIBRARY ASSOCIATION

*President*: Professor W. O. LESTER SMITH, C. B. E., *University of London.*

## Advantages of Membership

**Information Service and Advice**

- '**The School Librarian**' (termly journal: free to S.L.A. members). '*A quite admirable journal*' writes DR. ARUNDELL ESDAILE, M.B.E.

**Leaflets on Special Problems:**
1. *School Libraries in Library Classrooms;* 2. *Basic Stock;* 3. *Using the Library for Work in School;* 4. *Building a Secondary Modern School Library;* 5. *Reference Work in the Secondary Modern School;* 6. *Notes on Classification for Secondary Modern School Libraries;* 7. *First Steps in Administration for School Librarians.*

**Other publications at reduced prices:**
*School Libraries: a Short Manual by* C. A. STOTT, M.B.E.; *List of General Reference Books and of Books on Librarianship* (only a small stock remains); *School Libraries To-day:* New edition, with a Foreword by Professor W. O. LESTER SMITH, C.B.E.; *Sixty Books on Scotland suitable for School Libraries*, compiled by W. R. AITKEN, M.A., F.R.S.A., F.L.A.; *Eleven to Fifteen: A Basic Book List of Non-Fiction for Secondary School Libraries*, with a Foreword by RONALD GOULD, M.A. (2nd edition ready shortly); *Farming and Kindred Subjects: an Annotated Book List for Readers of Eleven to Fifteen Years*, compiled by A. VOYSEY of the N.F.Y.F.C.; *Scripture and Kindred Subjects* (compiled by the Institute of Christian Education).

**Annual subscription : £1 1s.**

Write now, without obligation, to the HON. SECRETARY, S.L.A. (Ref. G/1), GORDON HOUSE, 29 GORDON SQUARE, BLOOMSBURY, LONDON, W.C.1.

A CENTURY OF LONDON WEATHER

By W. A. L. Marshall

Details of London's weather since 1841 assembled in a form suitable for quick and reliable reference
(Illustrated) (M.O. 508)

Price 15s.

By post 15s. 4d.

*Obtainable from :*

H.M. STATIONERY OFFICE

P.O. Box 569, London S.E.1, and Sale Offices in London, Edinburgh, Manchester, Birmingham, Cardiff, Bristol and Belfast ; or through any bookseller.

**Geographical Field Group**

*Hon. President :*
**Prof. K. C. Edwards,** M.A.Ph.D., F.R.G.S.

*Hon. Vice Presidents :*
**Miss A. Garnett,** B.A., Ph.D.
**A. E. Moodie, Esq.,** B.A., Ph.D.
**N. V. Scarfe, Esq.,** M.A.

The Geographical Field Group is a non-profit making organisation which arranges for parties of geographers to carry out field-work abroad under qualified leaders. In 1953 Dr. Moodie will lead a party in the Soca Valley, Yugoslavia, from August 4th to 27th, and Dr. G. H. Dury will lead a party at Kungalv in Sweden, from August 7th to 27th. The inclusive cost in both cases is £31.

Full particulars of the group and its activities may be obtained from the Hon. Secretary, Miss N. F. Lockton, The Hollies, Nottingham Road, Ashby-de-la-Zouch, Leics.

physical features shown on human life and activities. This may indicate not a decrease of interest in human geography but an increasing ability to appreciate the photograph as a landscape, without the felt need, clearly shown by the younger children, to put people into the scene.

The final conclusion which may be suggested as arising from this experiment can be summarised as follows :—

(1) Photographs, to interest and attract the child, need to be bright and clear.
(2) Photographs showing a variety of detail may interest more than those lacking contrasts.
(3) Photographs may stimulate a desire to know more.
(4) Parts, not wholes ; details, not a broad view ; a general lack of integration characterise the child's approach in picture study.
(5) The ability to make simple deductions from pictorial data probably increases with age, experience and intelligence, but appears to be present even in some 10-year-olds.
(6) Emotion plays a large part in the interest and appreciation of pictures by children, but appears to play a decreasing part with increasing age. Nevertheless, it is probably always a potent factor in the learning situation.
(7) It would seem that young children show little natural interest in the causes of physical phenomena of the normal type selected for this particular pictorial representation.

It will be apparent to the discerning teacher that children need guidance in the selection of photographic detail for close study, and careful and constant training not only in the appreciation of size but in the perception of wholes. It will be equally apparent that, even for young children, pictures present a valuable source of geographic data—no less powerful in the field of learning because children find them an equally valuable source of interest and enjoyment.

◆

# BLACKBOARD OUTLINE MAPS

H. C. PRUDDEN

IN most schools where geography is taught the blackboard and printed wall map are considered essential for teaching. However, the teacher conducting classwork frequently finds that he needs a combination of the two, that is, an outline of the world or a continent on which he can add or erase at will detail in chalk. To draw such an outline free-hand requires both skill and time, although the use of a template results in a more accurate outline in less time. But with both methods the outline may be lost or smudged when detail is erased. Hence the need for permanent outline maps for classroom use. Since the bought article may not always be satisfactory or available, the writer recommends teachers to make their own.

The material selected for such a map should not tear or crinkle easily, the surface should be smooth and the sheet should roll up and unroll with ease. Paper used in the craft room for book covers is quite suitable. Cloth fabrics may also be used. Two coats of blackboard paint should be applied with a 2-in. brush and the sheet laid flat for drying. The next step is to make a tracing of the selected outline and to chalk the back of it. Published wall maps provide useful outlines for map copying. The tracing is then laid on the blackboard sheet and the outline pencilled over, thus leaving a chalk outline on the blackboard. This outline may then be painted, say in yellow, with a line as dense as possible and about $\frac{1}{10}$th inch wide. It is also very helpful with some maps, both for teacher and pupil, to insert prominent rivers in a thinner line. Finally, the map may be mounted on a light wooden rod, other edges being protected with tape.

The blackboard outline map can be used very effectively for presenting, summarising and testing regional studies. It should be noted that the process of chalking in detail, such as coalfields or shipping routes, is more exacting for the teacher than vaguely waving a finger at a printed wall map which may not show the features under discussion. However, this method has important advantages for the detail grows before the eye and there is little to distract the class from the subject in hand. It lessens the risk of confronting young minds with the mass of symbols used on the printed map to represent realities with which the pupils may be quite unfamiliar. Pupils may be given frequent opportunities to mark in important geographical facts and the regular use of a world outline in this way, for a few minutes, in, say, every other lesson may be most helpful. Such maps may also relieve pressure on blackboard space though, for effective use, they should be properly hung or fixed against a flat surface.

This method is simple and inexpensive and experience has shown the considerable enjoyment and benefit which both teacher and pupil may derive from its regular use.

The Department of Geography in the University of Sheffield makes considerable use of portable blackboards supplied by the North of England School Furnishing Company. These are supplementary to the permanent blackboard extending the length of the wall and can be inserted in the frame in front of it and removed at will. It has proved very useful to paint one of these boards with a map outline as described by Mr. Prudden and we recommend the practice.—Ed.

# *John Murray*

## An Introduction to Economic Geography

**N. J. G. POUNDS, M.A., Ph.D.**

This Economics Geography is intended for use in the sixth form. It provides an introduction to the subject and a background to the more detailed regional studies which it will normally accompany. The many specially drawn maps and diagrams are a valuable feature of the work.
*2nd Printing.* 10*s*. 6*d*.

## Europe

**W. J. H. WATKINS, M.A., B.Sc.**

This is a textbook in geography for the General Certificate (O.L.). Some chapters have been kept back until the last moment in order that the current state of affairs in a disorganised Europe may be as faithfully represented as possible, and care has been taken that in doing so the consideration given to smaller States should be adequate. A special feature of the book is the lavish scale of illustrations.
7*s*. 6*d*.

*FOR THE GEOGRAPHY LIBRARY*

## In the Antarctic

**F. DEBENHAM**

First-hand stories of Scott's " Last Expedition " written by the Geologist of the party. Here are glimpses of the lighter moments in the story, glimpses which reveal what these men were really like. The episodes are interspersed with extracts from the lighthearted magazine *The South Polar Times*.
*School Edition.* 5*s*.

**TRANSPORT BY AIR**
**TRANSPORT BY SEA**
**TRANSPORT BY LAND**

Designed and edited by PAUL REDMAYNE, M.A. These books give, mainly by pictures, vivid accounts of the evolution of transport by land, sea and air from the earliest time to the present-day. 8*s*. 6*d*. *net each.*

**ALBEMARLE STREET, LONDON, W.1**

# PHYSICAL GEOGRAPHY AND CLIMATOLOGY

N. K. HORROCKS, B.Sc.

*Senior Geography Master, Central High School, Manchester*

With a Foreword by
Professor S. W. WOOLDRIDGE, D.Sc.

The purpose of this book is to provide a comprehensive account of the several aspects of physical geography. It is intended primarily for pupils in secondary grammar schools who are preparing for an examination in geography at an advanced level, and also for those pupils who will reach scholarship standard.

The book is divided into six parts:

STRUCTURE OF THE EARTH'S SURFACE
EARTH SCULPTURE
METEOROLOGY
PLANTS AND SOILS
CLIMATOLOGY
OCEANOGRAPHY

It contains diagrams and photographs, and an index.

Ready June, probably 18s.

**LONGMANS**

**6 and 7, CLIFFORD STREET, LONDON, W.1**

# OBITUARY

## SIR CHARLES ARDEN-CLOSE, K.B.E., C.B., C.M.G., F.R.S.

Colonel Sir Charles Arden-Close, born in 1865, died on 19th December, 1952, at the age of 87 years. He presided over our Association in 1927 just before his election to the presidency of the Royal Geographical Society, which office had become vacant through the death of Dr. Hogarth. Sir Charles was a thinker as well as a great technician in all that pertains to maps and map-making. In this technical field his text-book of Topographical Surveying has long been a classic, and his directorship of the Ordnance Survey (1911–1922) raised standards of production notably. His endeavour was always to combine scientific precision with humanist appreciation and artistic production. Among his many services to the Ordnance Survey a very successful one was the appointment of an Archæological Officer, and he secured O. G. S. Crawford for his new post, with results well known to us all.

Sir Charles was deeply interested in the theory of history and the philosophy of religion, and it was a pleasure to converse with him about these wide topics. He was naturally led to work for the International Population Union, over which he presided from 1931 to 1937, and he wrote articles until very recently on population and international relations.

Our Association is grateful for his friendly interest and encouragement of its work and for his active sympathy with its officers.

H. J. FLEURE.

◆

# CORRESPONDENCE

## WEATHER RECORDS

A scheme for the mutual interchange of meteorological information between secondary schools in Great Britain is now in operation. To make the scheme more representative and of increased value to all those schools participating requires the co-operation of schools in Wales, northern England, Scotland and Northern Ireland. There is a good spread of schools already participating in the south of this country. Would any school wishing to join the scheme, or anyone requiring information concerning it please write to me and enclose a stamped (1½d.) foolscap envelope for reply.

E. R. FRANKLIN.

The Village College,
Impington, Cambridgeshire.
December, 1952.

## The Secondary School Atlas

The Memorandum by the Committee of the Secondary Schools Section of the Geographical Association which appeared in the January number of *Geography* will doubtless focus attention once more on a subject of fundamental importance to all teachers of geography.

The Committee discusses "the secondary school atlas," implying that one kind of atlas may be suitable and adequate for all secondary school classes in the age range 11–16 years. In the opinion of the writer, at least two kinds of atlas are essential, the younger children requiring one that is smaller and simpler than that for the more mature scholars. The size of atlas suggested (10 × 9 inches) might well be changed to 11 × 9 inches, which is already the size of many school atlases.

There is a great deal to be said for a loose-leaf atlas, which could be strongly bound and would certainly open flat, in accordance with the Committee's suggestions. It may be objected that a loose-leaf atlas would cost rather more than the conventional type. It is perhaps difficult to assess the relative costs, but one feels that they would not greatly differ, and that the many advantages of the loose-leaf atlas would outweigh even a substantial increase in cost.

The advantages that come to mind are these :—

1. Maps of the same continent or region could be supplied with varying detail in accordance with the age of the pupils using them.

2. Maps could be either single or double sheets.

3. The pupils need receive only the maps relevant to the work of the term.

4. Relatively large-scale maps of the regions of the British Isles, and of other regions, such as New England, the St. Lawrence—Great Lakes, South-east Australia, the Rhineland, Palestine, Malaya, Japan, which may not be included in the normal atlas, could be provided, thus making provision for detailed studies of selected regions.

5. Special maps of the home district and of other areas—Ordnance Survey one-inch and six-inch, land utilisation, geological, etc., could be inserted.

6. Maps prepared and duplicated by the teacher can be added.

7. Photographs, statistical diagrams, and other material would increase the value of the atlas.

8. Changing international boundaries would not render the atlas obsolete : the map indicating new boundaries can be added to that recording the older boundaries.

9. A great advantage would be that different maps, photographs, and the like, could be extracted for comparative examination—a practice not possible with the conventional atlas. The tracing of maps would also be a simpler operation when a single sheet can be taken from the atlas.

10. Maps, climate and trade graphs, and other material produced by the individual pupil, could form an integral part of the atlas. This

is a point of great importance : it would give a strong sense of pride in "*my* atlas."

World maps might be printed on the inner sides of the loose-leaf cover. The school would obtain stocks of the maps it proposed to use, and would be spared the expense of the many maps included in the school atlas that are never utilised. The loose-leaf atlas would certainly meet the needs of teachers whose "personal tastes and desires . . . differ so widely." The teacher could decide the contents of every atlas.

EDWARD V. LANE.

Trinity College, Dublin.
March, 1953.

## INSTRUMENTS FOR GEOGRAPHY

During the past few years I have come across several items of ex-Government equipment which have proved to be admirable additions to our geography apparatus. Other teachers may be glad to hear of these bargains and may be able to contribute similar information of value, based on their own actual experience. Here are a few items to set the ball rolling.

*Astro-compasses* (Pride and Clarke, Stockwell Road, Brixton). I have used these as theodolites for class teaching and find them ideal. We get quite accurate results, and as they cost only 8s. 6d. (carriage extra) they can be safely placed in children's hands. The army heliograph stand is an excellent tripod for them. Gamages of Holborn may have a few of these left at 5s. 6d.

*Bubble sextants Mk. IXA.* These are very useful instruments for the top classes. They can be used as Abney levels, dumpy levels (when set at zero), clinometers and, of course, as sextants. They are obtainable at Devonia Marine, 32/34, Victoria Parade, Torquay, for 37s. 6d. plus 2s. 6d. carriage. Ours is in almost constant use, and one boy has bought one for his own use !

*R.A.F. Sensitive altimeters.* This is the most sensitive aneroid I have ever seen. When used as an altimeter it reads to the nearest 10 feet with ease and is ideal for rough contouring. Mine cost 17s. plus 1s. 6d. postage from E.P.E. Ltd., Windmill Hill, Ruislip, Middlesex.

*Strut type psychrometer.* These are rather difficult to find around here. They are excellent wet and dry bulb thermometers but have the disadvantage of being far too big to fit in a normal Stevenson screen. However, they are fitted with a screen which can easily be modified for ground use. These instruments were available last year for 25s.

What can other readers recommend ?

BRO. REGINALD,
Chairman, Portsmouth and District Branch.

St. John's College,
Southsea.
January, 1953.

# GEOGRAPHICAL ASSOCIATION

## THE ANNUAL CONFERENCE

### 31st December, 1952–3rd January, 1953.

Once again, thanks to the energetic and efficient work of the Hon. Conference Organiser, Dr. Balchin, a very successful Annual Conference was held at the London School of Economics, by courtesy of Sir Alexander Carr-Saunders, to whom we are greatly indebted for the use of the college buildings.

All the meetings were well attended. They included Section meetings for the discussion of topics concerned with teaching, teaching techniques in secondary schools, university entrance examination requirements, the use of models in teaching physical geography, sample studies for children 8–12 and geography and the educational experiment at the University College of North Staffordshire.

One morning was devoted to more academic interest with stimulating lectures by Professor Austin Miller on "Recent trends in climatology and related problems of teaching," and by Mr. B. H. Farmer on "Some problems of Ceylon." It was appropriate, also, that one other morning was spent on accounts of various aspects of North American geography presented by some of the members who attended the meetings and excursions held in connection with the XVIIth Congress of the International Geographical Union at Washington in August, 1952.

On January 2nd we were deeply indebted yet again to the Royal Geographical Society for lavish hospitality when tea was served to no less than 700 to 800 geographers. This was the occasion of a joint meeting of the Institute of British Geographers, the Geographical Association and the Royal Geographical Society, when Professor Darby gave an address on "The relations of geography and history." It was a great occasion in every respect.

On Saturday, members were offered four excursions, to the Hydrographic Department of the Admiralty, the Central Forecasting Office at Dunstable, the laboratories of Hunting Aerosurveys, and an excursion by coach for field studies in the central Weald, under the able direction of Dr. Briault. We are indeed greatly indebted to all who helped to organise and lead these ventures.

An innovation in the programme this year was the account of "Home environment" given by three speakers, respectively natives of British Honduras, and West and East Africa. A special word of thanks is due to our overseas friends who gave these informative addresses. To the National Committee for Visual Aids in Education we are also grateful for Visual Aids in a programme and demonstration of recent geographical films.

The Westminster Branch once more extended generous hospitality, inviting all members attending the conference to tea on one of the afternoons, despite the large numbers involved by the record attendances. For this gesture we extend cordial thanks. The hospitality was reciprocated by non-metropolitan branches and members at tea on the succeeding afternoon. The 22nd Annual Dinner was well attended, under the chairmanship of Professor Dudley Stamp, whom we were very glad indeed to welcome in this capacity.

Alice Garnett.

## Diamond Jubilee Meeting

1953 marks the Association's Diamond Jubilee, and in the course of the year an enlarged "Diamond Jubilee" issue of *Geography* will be published and circulated to all members. We hope also to hold a special Jubilee meeting early in the autumn in Sheffield, and that this will be well attended by members. Midland branches of the Association may feel able to consider the possibility of organising an all-day Saturday excursion by coach. For other members coming from a greater distance, every effort will be made by headquarters to provide accommodation for one or more nights, if due notice is given. The date and details of these celebrations will be given in the next issue of *Geography*.

## Section for Further Education in Geography

On the recommendation of Council, a new Section of the Association is now being formed, to consider problems concerned with the teaching of geography in all institutions concerned with Further Education (e.g. Technical Colleges, Day Continuation and Commercial Colleges, etc.). Those interested in the work of this new Section should write to Mr. W. Wallace, at 5, Angus Road, Worthing, Sussex, who has been asked by the executive committee to act as chairman of the foundation committee.

Enquiries regarding Secondary Technical Schools and Junior Technical Departments will still fall within the scope of the existing Secondary Schools Section.

### New Branches

A new branch has recently been formed at Reading. The local secretary (to whom application for details of branch activities should be made) is Mr. P. D. Wood of the Department of Geography, University of Reading.

### Summer School at Pulborough, 1953

There are now only about 15 vacancies in this School, and members are advised to make early application to the Assistant Secretary if they wish to register and have not already done so. An information leaflet is enclosed with this issue of *Geography*.

### Summer School in Brittany, 1954

It has been proposed that a Summer School of Geography shall be organised abroad in 1954. Professor E. G. Bowen has very generously offered to work out provisional plans for a School to be held if possible during August, 1954, in Brittany, with headquarters at Rennes. It would be very helpful if any members who are interested and likely to participate in such a venture would inform the Assistant Secretary at our Sheffield headquarters as soon as possible, so that some provisional estimates of numbers, requirements for accommodation, costing, etc., can be made, without which even provisional plans cannot be formulated. If organised, the School will be under the direction of Professor Bowen with, it is hoped, assistance from British and French University geographers.

### *Geography in the Primary School.*

The second (revised) edition of this handbook is now on sale (2/-) and we shall be grateful for the assistance of members in making this publication as widely known as possible.

### Instructions to Authors

The Honorary Editor draws the attention of members to the instructions for authors wishing to submit material for publication in *Geography*. These are printed on the inside back cover of this issue.

### Recent Appointments

We extend warm congratulations to Mr. E. W. Gilbert on his appointment to the Chair of Geography at the University of Oxford ; to Mr. Keith Buchanan on his appointment to the Chair of Geography at Wellington, New Zealand ; and to Mr. A. E. Smailes who succeeds Dr. Crowe as Reader and Head of the Department of Geography at Queen Mary College, London.

Members may be interested to learn that, on the retirement of Sir Harry Lindsay, Mr. Kenneth Bradley has been appointed his successor as Director of the Imperial Institute, South Kensington.

### Geography in the Higher Civil Service Examination

Members will be glad to have preliminary notice of changes in the status of geography in the Administrative Class of the Home Civil Service Examinations, to take effect in 1954. Geography will then carry 700 marks, which means that those candidates who take geography as an optional subject can now score the requisite number of marks on this subject alone, without the help of additional optional subjects. Sixth Form scholars in grammar schools who may be considering the possibility of a career in the Civil Service may be encouraged therefore to proceed to a university to read geography as a subject for an Honours degree with this new position in mind.

Specimen question papers based on the new syllabus in geography will be obtainable shortly from the Civil Service Commission to whom application should be made. They will also be included in the pamphlet of question papers set for the examinations of 1953 which will be published by H.M. Stationery Office at the end of this year. Six papers and one practical test are to be included. They share marks as follows : Physical Geography (2 papers)—200 marks ; Human Geography (3 papers)—300 marks ; British Isles (1 paper)—100 marks ; Practical Test—100 marks.

Further information will be given in the pages of *Geography* in due course.

### WATER AND CONTOUR PULLS

Owing to increases in the price of O.S. maps, as from March 1st, 1953, water and contour "pulls" ordered through the Geographical Association will be supplied at the following rates: 1 inch sheets, 3/– each; 1/25,000 sheets, 2/6 each; ¼ inch sheets, 2/6 each (as before).

### LOCAL STUDY IN G.C.E. GEOGRAPHY

As an experiment for 1952 and 1953, the University of Cambridge Local Examinations Syndicate introduced into their G.C.E. Geography, at advanced and scholarship levels, a scheme under which candidates in schools near Cambridge might receive credit for an individual study in local geography. It is good news that for 1954 the scheme is to be made optional for all the schools taking this examination. The examining of the local studies, presented in the forms of maps, diagrams and written work not exceeding 4,000 words in length, may include an interview, though it will not be possible to interview all candidates. Marks obtained will be reckoned as 15 per cent. of the advanced level total but only if it is to the advantage of the candidate. This recognition of the value of field work, in the examination arrangements, is an advance which will be widely welcomed by geography teachers everywhere. Those whose pupils sit for other G.C.E. examinations may hope, and perhaps feel inclined to urge, that a similar scheme may be extended to their candidates.

E.W.H.B.

### SPECIALISATION IN 6TH FORM GEOGRAPHY

The Association of University Teachers is conducting an investigation into the matter brought to its attention of complaints of over-specialisation in the 6th forms at schools. The opinion and detailed recommendations of the Geographical Association have been sought in this enquiry, in particular concerning the content, scope and method of assessment at the present level of G.C.E. Advanced and Scholarship papers, and their effect on the school curriculum. Factual information and the views of teachers of geography on these and other relevant problems would be welcomed. The Honorary Secretary has asked the Secondary Schools Committee to undertake an enquiry through its members, and at headquarters office we should be glad to receive the expressions of opinion of any other teachers concerned with 6th form geography teaching.

## REVIEWS OF BOOKS

**The Origin of the Broads.** J. N. Jennings. 18 × 24 cm. 66 pp. London. Royal Geographical Society (J. Murray, Ltd.). 1952. 10/–.

Mr. Jenning's monograph is a major contribution to a topic which has been under discussion for the last 100 years. For the first time the stratigraphy of the alluvial deposits underlying the Broads has been firmly established. Cross-sections have been constructed across the valleys at a number of points with the help of a hand peat-borer, which often penetrated to depths of more than 20 feet. The pollen, foraminifera and mollusca from certain borings were submitted to experts, whose conclusions are given as appendices. The Broads are shown to have been formed by a marine transgression commencing in sub-Atlantic times: a transgression which was interrupted by halts, when peats spread seawards over estuarine clays and silts. Many minor points, such as the origin of the 'ronds' which separate certain broads from the main rivers, are fully discussed in this authoritative and excellently illustrated monograph.

J.F.K.

**A Traveller in Venice.** Derek Patmore. 14·5 × 22 cm. 183 pp. London. Methuen & Co., Ltd. 1951. 15/–.

This book, like its predecessor *Italian Pageant*, is purely descriptive and concerned mainly with Venice and other towns of north-east Italy as museums of beauty. Mr. Patmore writes as a post-war traveller who finds fascination in the events of everyday life as much as in priceless works of art. He writes in a personal and entertaining style which makes his book worth reading though of no serious interest to the student of geography.

A.J.H.

**Scandinavia.** Ed. Doré Ogrizek. 14·5 × 19·5 cm. 438 pp. London. McGraw-Hill Book Co., Ltd. 1952. 30/–.

The French authors of this book and their American translators have produced a text which, though sometimes naïve, has considerable freshness for a British reader. Copious illustrations are provided by an international group of artists who often use very effective colour. The maps are unsuitable for adults. Chapters on art, literature and history (to be read, preferably, in reverse order) are followed by descriptions of Sweden, by one author, and of Denmark, Norway, Finland and Iceland by another. They view these countries from different angles and thereby show part of the common heritage of the Scandinavian peoples and some of their differing reactions to differing environments. If he believes everything in this romantic and exuberant book the tourist may be disappointed in post-war Scandinavia, notably in Denmark and Norway. A tourist handbook needs an index. M.D.

**Scandinavia.** E. de Mare. 14·25 × 22 cm. x + 262 pp. London. B. T. Batsford, Ltd. 1952. 21/–.

The ambitious purpose of this book is to convey as clear and detailed a picture as possible of Sweden, Denmark and Norway. Each country has chapters on its Land and Livelihood, its History and Heritage, and on various topographical divisions. A final chapter, "The Proper Study," attempts an analysis of the psychology and national character of the Scandinavian peoples. The author is an architect who believes that architecture reveals a nation more clearly than any other art. As a result these countries receive very unequal treatment. The section on Sweden occupies more than half the book and Norway is described even more briefly than Denmark. The illustrations, although of the high standard expected of the publishers, are mainly architectural.

F.R.G.

**Additional Chapters to H. W. Codrington's "A Short History of Ceylon."** L. H. Horace Perera. 12 × 18 cm. 246 + 182 pp. London. MacMillan & Co., Ltd. 1952. 2/–.

The four chapters in this well-written little book give a very good picture of Ceylon's passage, in the years from 1833 to the present time, at first unsteady and later more smooth, on the road to Dominion status. Geographers will probably be most interested in the chapter on Economic and Social Development. The changing fortunes of cinnamon, coffee, tea, rubber, and other cultivations are described not only in relation to the world market situation which most people know something about, but also to such things as Sinhalese village custom and organisation, which are less well known. F.H.W.G.

**Geodesy.** G. Bomford. 16 × 24·5 cm. xiii + 452 pp. London. Oxford University Press. 1952. 50/–.

This treatise, by the Reader in Surveying at Oxford, formerly an officer in the Survey of India, has indeed filled a gap which existed for too many years in English scientific literature. The field methods and mathematical foundations of surveying for the investigation of the size, shape and structure of the Earth and the accurate mapping of its surface, are the author's themes. In these he is a recognised expert. The well-established processes of base-measurement, geodetic triangulation, field astronomy, etc., are dealt with in the first five chapters of the book. Concise treatment of these subjects (which the student can find described fully in available textbooks) leaves room, within a reasonable compass, for more extended writing on gravity surveying and other geophysical methods which have a rapidly growing literature. In the final chapter, the determination of the figure of the earth, the investigation of the earth's crustal structure, and the various theories of crustal formation and compensation, are lucidly discussed. Some useful technical appendices, and a very comprehensive bibliography, complete this excellent work. J.E.J.

**Geological Survey of Great Britain.** Sir Edward Bailey. 14 × 22 cm. xii + 278 pp. London. T. Murby and Sons. 1952. 22/6.

Sir Edward Bailey has done a service to science in this book which covers the work of the Geological Survey from its inception to the close of the second World War. The story is told in chapters each devoted to the term of office of a director, a method that gives opportunity for studying the impact of different minds on a public service. It is eminently readable and the author has much to tell us of the characters of the great geologists of the past, of the relation of the service to the development of the science and of the part played by its members in some of the burning controversies of earlier days. It is a book that will be read with pleasure and profit by all who are interested in the history of science W.H.W.

**Guide to Geologic Literature.** Richard M. Pearl. 16 × 23·5 cm. xi + 239 pp. London. McGraw-Hill Book Co. 1951. 32/–.

This book has been written with the intention of helping research workers to find all published information available on any branch of geology. In this it largely succeeds. It contains much useful information with regard to the government publications of America and elsewhere and gives extensive references to lists and catalogues from which the names of all kinds of unofficial books and journals can be obtained. This information is wide and is extended to cover the means of access to doctors' theses and other unpublished works. One or two criticisms may be made. Some of the lists have rather curious omissions: e.g. the list of maps and memoirs of the Irish Geological Survey is given while those of the Geological Survey of Great Britain are omitted. Also, rather an undue amount of space is taken up with what is common knowledge so that some reduction in length might have been made without sacrificing any essential material. W.H.W.

**Soil and Civilisation.** E. Hyams. 14·5 × 22·25 cm. vii + 312 pp. London. Thames & Hudson, Ltd. 1952. 21/–.

This book is a tract, an exposition of a point of view. The theme is the biological unity of soil and of plant and animal life, including man. Hunters are members of the soil community, to use the author's terminology, pastoralists conservers of the soil community, farmers creators of an artificial soil community if they add fertility to the soil but parasites if they practise a robber economy. The author illustrates his argument with historical and modern examples taken from a wide range of space and time. The theme is not unfamiliar. It has been expounded before, and more successfully in relation to the robber farming economies of the modern world by G. V. Jacks and R. O. Whyte. Hyams commits himself, for example, to some sweeping and erroneous statements on the relation between forests and rainfall and on climate generally. Again, the idea of harmony between Nature and Man was expressed by Franz Schrader in the First Herbertson Memorial Lecture delivered in Oxford and in Liverpool in 1918. Hyams, Jacks, Fraser Darling and others define the theme as Human Ecology: some twenty or thirty years ago it used to be discussed within the context of Human Geography.

The author has the practical experience of a farmer and the instincts of a countryman. He writes well on farming and has an occasional sentence of fine quality. He talks the language and upholds the objectives of the compost farmer: he expresses the objections of the compost school to the chemist and his artificial fertilizers so long as the chemist takes the view "that the existence of chemical fertilizers emancipates him for responsibility towards the soil as a living organism." The argument backwards and forwards in the debate between the two schools is a very interesting one, though Hyams is biassed in favour of the compost school, and is one of considerable geographical interest. W.S.

**Commercial Geography.** S. Hall. 13 × 19 cm. viii + 478 pp. London. Isaac Pitman & Sons. 1952. 15/–.

Although written on a World basis, this book deals particularly with the British Commonwealth and Colonies. It assumes some knowledge of fundamentals, but includes a concentrated, preliminary section on essential principles. The author has set himself a formidable task, and his abrupt style emphasises the condensation necessary in so broad a field. Nevertheless, the book can perform a useful function as a text for students taking commercial courses, or studying up to the old Intermediate level. The maps and diagrams are well drawn, but in some instances, the attempt to simplify has detracted from their value, e.g. Figs. 38 and 97. The text shows few errors, but the revision of such statements as, "wheat-growing areas are in lands with a cool temperate oceanic climate" (p. 73), is necessary. These faults can be remedied, and it would be unfair to place undue emphasis upon them. K.R.S.

THIRD EDITION

# The Teaching of Geography

## IN SECONDARY SCHOOLS

When the first edition of the *Memorandum on the Teaching of Geography*
appeared in 1936 it was immediately recognised
as the most authoritative report on the aim
and scope of geography teaching in the Secondary Schools.
In this third edition the original text has been reviewed,
revised and enlarged in the light of experience and
recent development.

The requirements of the 1944 Education Act
have been fully covered, as can be seen in the
complete chapter devoted to
Geography Teaching in Secondary Modern Schools.
The modification of examination regulations
under the new Act
has meant considerable changes in the text,
notably the curtailment of the section on Examinations.

Much in the chapters on Teaching Methods and
Equipment has been rewritten
and the sections dealing with Visual Aids
have been expanded
to include some account of recent developments.
The chapter on Geography Outside the Time-Table
has been extended
to include, besides School Camps,
both School Exchanges and Foreign Travel.

528 pages, with 60 illustrations. 7½ in. x 4½ in.

Cloth boards, 17s. 6d.

Published for
the Incorporated Association of Assistant Masters in
Secondary Schools

George Philip & Son Ltd
30–32, FLEET STREET, LONDON, E.C.4.

THE TEACHING OF GEOGRAPHY IN SECONDARY SCHOOLS

## *Advanced Geographies*

new volumes now available

### GERMANY

**A General and Regional Geography**

**ROBERT E. DICKINSON**

*Professor of Geography in Syracuse University, N.Y., U.S.A.*

This book is based on a thorough study over many years of the geography of Germany. While the work primarily has reference to the Germany of 1939, the post-war trends are examined in their geographical significance. The work should serve as a basis for assessing the problems and possibilities of the post-war Germany that arise from the changes in its economy and population and from its changed situation in the European scene. With 32 illustrations and 124 maps and diagrams. 50*s.*

### MAPS AND DIAGRAMS

**Their Compilation and Construction**

**F. J. MONKHOUSE and H. R. WILKINSON**

*Department of Geography, University of Liverpool*

" The outstanding textbook on cartographical methods so far published in the English language. . . . It should become a standard work of reference." *Geography.*

" A work of reference no serious geographer can afford not to possess." *Higher Education Journal.*

With 199 illustrations. 25*s.*

*IN THE PRESS*

### INDIA AND PAKISTAN

**A Social and Regional Geography**

**O. H. K. SPATE**

*Professor of Geography in the Australian National University, Canberra*

Probably the most comprehensive modern treatment of the subject in any language, this book contains much material unfamiliar to Western geographers.

With a frontispiece and 157 maps. 60*s.*

METHUEN & CO. LTD.

**36, ESSEX STREET, LONDON, W.C.2**

# WORLD AFFAIRS

## . . . in *Pictures*

We are pleased to announce four new sets of Wall Charts on various aspects of World Affairs. These charts, printed in full colour, give the young mind a picture of the subject which words, however well chosen, cannot give ; they will prove invaluable to every teacher of social studies and current events.

THE BRITISH MONARCHY.

Three charts giving the history and duties of the Monarch.

1. The rise and fall of the Monarch's powers over the last few centuries.
2. Duties of the Monarch as head of state, etc.
3. Residences, income and ceremonial uniforms price **15**/- the set.

U.S. CONSTITUTION.

Four charts :

1. Forming of constitution from a historical point of view.
2. Federal Government ; duties of Legislative, Executive and Judicial Branches.
3. Various responsibilities of Federal and State Government.
4. Voting procedure and system of electing President price **20**/- the set.

COLOMBO PLAN.

Two charts of area concerned. Reason for plan and benefits the countries will receive from sponsor nations price **10**/- the set.

ISLAM.

Three charts :

1. Birth of Islam and brief history and precepts.
2. Growth of Islam and influence on West.
3. Islam today : different types of people price **15**/- the set.

Write NOW for : Complete catalogue of Wall Charts and Books.
Complete catalogue of Filmstrips and Film Loops.
We will be very pleased to add your name to our REGULAR MAILING LIST.

**EDUCATIONAL PRODUCTIONS**
**LIMITED · 17 DENBIGH STREET LONDON S.W.1**

# *Map Interpretation*

*By*
G. H. Dury, M.A., Ph.D.,
*with a foreword by*
A. E. Moodie, B.A., Ph.D

The student who masters the principles laid down in this book will be well on the way to a mastery of map interpretation. Emphasis is laid on the importance of an adequate knowledge of physical geography in map interpretation, and the close relationships between man and nature are brought out clearly. Numerous photographs, charts, and maps are given, and at the end of each chapter there is an extensive and carefully selected bibliography. **15/– net.**

***Pitman*** **Parker Street, Kingsway, London, W.C.2**

**HARRAP**

**The Earth, Man's Heritage**

**By W. F. MORRIS, B.A., F.R.G.S., with the co-operation of R. W. BROOKER, M.A.**

This third volume in *The Charter Geographies* surveys the world as the home of man. It contains a considerable amount of descriptive material concerning the various natural regions whilst the underlying facts of physical geography receive adequate attention.
*Illustrated with photographs and maps.* 8*s.* 6*d.*

The other two volumes in this series, both by Mr. Brooker, are **The World's Wealth** (6*s.* 6*d.*) and **The Homeland** (8*s.* 6*d.*).

**Our Food and Our Clothes**

**By H. ALNWICK, M.C., B.A.**

" Juniors will be delighted with this new geography. It starts in a cheerful way with simple accounts of commodities in everyday use and gently and skilfully shifts the emphasis to sound geographical principles. . . . Lively drawings adorn each page of the book."—*Schoolmaster. Second Impression.* 7*s.* 6*d.* *Library Edition,* 9*s.* 6*d.* net

**182 HIGH HOLBORN, LONDON, W.C.1**

60 COPIES PER MINUTE

NO PREPARATION
Ready for immediate use.

*FOR CURRENT EVENTS :*
M.38. Japan M.41. Malaya M.125. Kenya M.128. Far East M.138. Korea

*FOR SCHOOL JOURNEYS :*
M.140. London
M.156. Paris
M.70. North Sea
M.24. Switzerland
M.26. Holland and Belgium
M.102. English Channel

*OTHER NEW ADDITIONS :*
M.146. West Riding of Yorkshire
M.147. Tees-side
M.148. The Potteries
M.150. Sarawak
M.151. Cumberland and Westmorland
M.152. Suffolk
M.153. Derbyshire
M.154. Nottinghamshire
M.155. Nigeria
A.21. South Africa

**Local Rolls Made to Order** *Prices on Application*

**THE MAPOGRAPH CO. LTD.**
**440, HIGH ROAD, CHISWICK, LONDON, W.4.**
*Telephone :* CHIswick 5635 *Established* 1923

# ARTICLES FOR *GEOGRAPHY*

## Information for Contributors.

1. All MSS submitted for publication in *Geography* and all correspondence in connection therewith should be addressed to the Honorary Editor, Geographical Association, c/o Park Branch Library, Duke Street, Sheffield, 2.

2. Articles on any subject of geographical interest will be considered. Articles by practising teachers of geography or on the problems of teaching the subject are particularly welcome.

3. In view of the limited funds which the Association can devote to publication, articles should avoid elaboration in text or illustration and should be as brief as is consistent with satisfactory exposition. A normal article is 3,000–4,000 words long; publication of longer MSS may be delayed or impossible. Specific teaching points can often be adequately dealt with in 1,500 words and such short articles are much desired.

4. MSS should be clearly typed, with sufficient margin and double spacing. The number of words to the nearest 100 should be shown.

5. References to published works should take the following form:
   *Title of book*; place and date of publication, page reference.
   " Title of Article "; *title of Journal*, volume number, year of publication and page reference.

6. Galley proofs are submitted to authors for the detection and correction of printers' errors. Text alterations other than these cause unnecessary expense to the Association and should be avoided.

7. Maps and diagrams are commonly necessary for adequate presentation of geographical information, and articles for *Geography* are customarily illustrated by line diagrams. In order, however, to defray costs of blockmaking and to encourage economy in the use of text space, the executive committee of the Association decided in January 1952 to invite authors to contribute to the cost of illustrating their articles at the rate of 10/6 for one figure, 1 guinea for 2–4 figures, and 2 guineas for 5 or more.

8. The Association cannot at present contemplate illustrating articles by half-tone blocks unless it can be financially assisted in doing so.

9. Original drawings for line blocks should be drawn large enough to permit reduction by two to three times. If finished they should be in black Indian ink on white paper, but it is commonly advantageous to supply semi-finished drawings with all names in pencil for the addition of lettering by the Association's draughtsman. All maps should carry a scale and north point, and as far as possible all names mentioned in the text; all names should be checked for spelling.

10. The copyright of all articles and illustrations published is reserved by the Association.

GEOGRAPHY
AND FOOD RESOURCES

Week-end course, 22nd–26th May

*Westham House, Barford, Warwick*

Residential course on the study of geography in relation to food and agriculture

*Fee (including accommodation)*

£3 - 12 - 6

Full particulars of this and other courses at Newton Abbot, Bangor and St. Andrews from

**The General Secretary, Association of Agriculture,**
**238-40 Abbey House, 2 Victoria Street, London S.W.1**

*Summer 1953*

**Vacation Programme of Field Study Meetings**

| | |
|---|---|
| IRISH REPUBLIC. | Thursday, August 20th to Tuesday, September 1st. Headquarters : Lisdoonvarna, Co. Clare, Studies in agriculture, geology and physical geography, with Sir E. John Russell, Mr. R. S. Bacon, M.A., B.Sc., and Miss Margaret Tatton. |
| DOLOMITES, ITALY. | Tuesday, July 28th to Wednesday, August 12th. Headquarters : S. Vigilio di Marebbe. (1200-2000m). Leaders Mr. G. B. G. Bull, M.A., and Miss Betty Read, B.Sc., |
| HADRIAN'S WALL. | Monday, August 17th to Tuesday, August 25th. Headquarters : Hexham, Northumberland. Leaders Mr. J. P. Gillam, M.A., of King's College, University of Durham, and Miss C. Baker, M.A., F.S.A. |
| WHITSUN MEETING IN ANGLESEY. | May 22nd to 29th. At the temporary address of the Society. Write Miss Margaret Tatton, F.R.G.S., The Birlings, Birling Gap, Eastbourne, Sussex. |

## Publications of the Geographical Association

The following may be obtained from the Assistant Secretary, Geographical Association, c/o The Park Branch Library, Sheffield, 2.

1. *Local Studies.* Revised and enlarged edition (1949), prepared by members of the Secondary Schools Section Committee. With regional bibliography. Price 3/– post free ; if supplied through a bookseller, 3/3.
2. *Geography in the Primary School.* Second edition with revisions, 1953, prepared by a sub-committee of the Primary Schools and Training Colleges Section Committees. Price 2/– post free ; if supplied through a bookseller, 2/3.
3. *Geography in the Secondary School. With special reference to the Secondary Modern School.* 1952. Prepared by Dr. E. W. H. Briault and Mr. D. W. Shave. Price 2/– post free ; if supplied through a bookseller, 2/3.

Details of other publications, map sets and information leaflets supplied on request; please enclose stamped addressed envelope.